EXTENSION OF SALINE WATER PROGRAM

HEARING

BEFORE THE

SUBCOMMITTEE ON IRRIGATION AND RECLAMATION

OF THE

COMMITTEE ON INTERIOR AND INSULAR AFFAIRS UNITED STATES SENATE

EIGHTY-FOURTH CONGRESS

FIRST SESSION

ON

S. 516

A BILL TO AMEND THE ACT OF JULY 3, 1952, RELATING TO RESEARCH IN THE DEVELOPMENT AND UTILIZATION OF SALINE WATERS

APRIL 19, 1955

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EXTENSION OF SALINE WATER PROGRAM

TUESDAY, APRIL 19, 1955

UNITED STATES SENATE,
SUBCOMMITTEE ON IRRIGATION AND RECLAMATION OF THE
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS,
Washington, D. C.

The subcommittee met, pursuant to call, at 10 a. m., in room 224, Senate Office Building, Senator Clinton P. Anderson (chairman of the subcommittee) presiding.

Present: Senator Clinton P. Anderson, New Mexico (chairman of the subcommittee).

Present also: Stewart French, general counsel; N. D. McSherry, assistant chief clerk; Goodrich W. Lineweaver, staff member for reclamation; and Elmer K. Nelson, consulting engineer.

Senator ANDERSON. The hearing will be in order on Senate 516. May we have in the record in the first place a copy of the bill, Senate 516, and then a copy of the report of the Department of the Interior dated February 16, addressed to Senator Murray, with reference to this bill, and a copy of letter of March 2 of Donald R. Belcher, Assistant Director of the Bureau of the Budget.

(The bill S. 516, the report, and the letter referred to follow:)

[S. 516, 84th Cong., 1st sess.]

A BILL To amend the Act of July 3, 1952, relating to research in the development and utilization of saline waters

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Act of July 3, 1952 (66 Stat. 328; 42 U. S. C., secs. 1951 ff.), is hereby amended as follows:

(1) By modifying subsection (a) of section 2 of said Act so as to read: "by means of research grants and contracts as set forth in subsection (d) of this section and by use of the facilities of existing Federal scientific laboratories within the monetary limits set forth in section 8 of this Act, to conduct research and technical development work, to make careful engineering studies to ascertain the lowest investment and operating costs, and to determine the best plant designs and conditions of operation".

(2) By modifying section 8 of said Act so as to read: "There are authorized to be appropriated such sums, but not more than $6,000,000 in all, as may be required (a) to carry out the provisions of this Act during the fiscal years 1953 to 1963, inclusive, (b) to finance for not more than two years beyond the end of said period such grants, contracts, cooperative agreements, and studies as may heretofore have been undertaken pursuant to this Act, and (c) during the same additional period plus one more year, to correlate, coordinate, and round out the results of studies and research undertaken pursuant to this Act. Departmental expenses for direction of the program authorized by this Act and for the correlation and coordination of information as provided in subsection (d) of its section 2 shall not exceed $1,500,000, and not more than $500,000 shall be expended for research and development in Federal laboratories. Both of said sums shall be scheduled for expenditure in equal annual amounts insofar as is practicable."

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D. C., February 16, 1955.

Hon. JAMES E. MURRAY,
Chairman, Committee on Interior and Insular Affairs,
United States Senate, Washington, D. C.

MY DEAR SENATOR MURRAY: You have requested a report on S. 516, a bill to amend the act of July 3, 1952, relating to research in the development and utilization of saline waters.

The act of July 3, 1952 (66 Stat. 328, 42 U. S. C., 1952 edition, secs. 1951ff) authorized the appropriation of a total of $2 million to enable this Department to carry on, through contracts with private scientists and engineers, educational institutions, scientific organizations, and engineering firms, a 5-year research program looking to "the development of practicable low-cost means of producing from sea water, or from other saline waters, water of a quality suitable for agricultural, industrial, municipal, and other beneficial consumptive uses * * *."

Enactment of S. 516 would modify the basic act by extending the period under which operations can be conducted under it, by increasing the amount authorized to be appropriated for the conduct of these operations, and by permitting research to be carried on to a limited extent in existing Government laboratories.

It is the recommendation of this Department that S. 516 be enacted.

Continued expansion of our industries, our growing populations, and expanding agricultural production have increased tremendously the demand for large quantities of fresh water. This continued growth and expansion has placed a severe drain on our water resources in certain areas. In many instances, new reservoirs have had to be constructed and water transported over great distances, in other cases the water supply has been supplemented by new wells which have lowered the water table. The pumping of ground water for irrigation in many areas has been at rates considerably above the safe yields as estimated by the United States Geological Survey. The sources of water on which we normally rely are gradually being exhausted and, through use and reuse, the supplies derived from these sources are being contaminated. The need for finding additional fresh water sources therefore is obvious.

Results during the past year have demonstrated the need for, and usefulness of, a Government program of this nature. Most industrial firms do not feel justified in carrying on the development of saline water-conversion equipment beyond certain improvements in present equipment. To accomplish the demineralization of large quantities of saline water at a fraction of the present cost will, however, require much more development of new principles and processes than improvements in present processes. The Government program assures that research and development investigations will continue both on the development of new and untried methods and on improvements in present methods.

At the beginning of the program, the cost of converting sea water to fresh water by the best processes in use was estimated at about $400 to $500 an acre-foot. Accordingly two cost goals were set for the initial 5-year phase of the program, one for water for municipal and similar purposes and one for irrigation water. (For these criteria, no distinction is made as to whether the water to be converted is sea or brackish water.) These goals were $125 and $40 per acre-foot (38 and 12 cents per 1,000 gallons), respectively, and they were believed, on the basis of data then available, to represent about the maximum that could be borne by these types of use. Although considerable work remains to be done before those initial goals are fully realized, they are being approached and it is believed they can be reached and lowered if the research is continued. In other words, the results to date indicate that the conversion of sea water to fresh water at a price which municipal users and some industries might pay and the conversion of saline water to irrigation uses may be in sight.

Recent results have indicated that no single process will provide fresh water for all purposes at all locations and under all circumstances. Thus it is desirable that several different principles, processes, and combinations of processes be investigated and developed concurrently. In addition, it is becoming increasingly apparent that nonconventional low-cost energy (e. g., solar, wind, geothermal energy, etc.) must be investigated in connection with process development and use.

Preliminary results obtained from one vapor-compression investigation and extrapolated to large-scale operation indicate a good possibility of producing fresh water from sea water for approximately one-fourth the cost of distilling water by any process in use at present.

Preliminary estimates for a critical pressure device of large capacity likewise indicate that fresh water may be obtained from sea water at costs much below those of existing processes if 2 or 3 critical problems now under research study can be solved.

Other processes under development include an ion transfer membrane demineralizer which is undergoing field tests at the present time; various aspects of the vapor compression distillation process, some of which will reach field-testing stage next year; solar distillation, solvent extraction, freezing, osmotic processes, and ultrasonics.

Initially, most of the research and development on processes has been on a relatively small-scale laboratory basis and only nominal expenditures have been required. Much of this exploratory and more or less fundamental research needs to be continued. However, as individual processes which show sufficient promise are developed in the laboratory, pilot plants or field tests become necessary. Such tests are essential in order to obtain reliable cost estimates and information on the durability of the unit, down time, production capacity, power requirements, corrosion, etc. Developmental work, including field tests of this type, is more costly than laboratory investigations.

Under the provisions of the Saline Water Act of 1952, all work undertaken pursuant to that act must be completed prior to July 15, 1957, the anniversary of the date of the first appropriation to implement it. Not only all research activities and field tests under contract but also all reports thereon and the correlation and coordination of all data must be completed by that date.

Since most research and development contracts are for a period of about a year, it would thus be necessary to terminate most active research contracting by about December 1955 to permit completion of the work under the contract and final reporting of the results and conclusions of the program by July 1957. Only a small portion of the appropriations for fiscal year 1957 could be utilized for contract research just at the time when the need for advanced research and development of promising processes is expected to be paramount.

To permit continuity and the attainment of the program's goals, an extension of time is desirable. The results obtained to date are, as has already been noted, sufficiently encouraging toindicate that, if the activity is given sufficient time, economical processes for the treatment of brackish water and sea water will be developed. Research of this type is perforce long-range in character. Unless assurance can be given to the private firms and research organizations who are serving or will serve the program as contractors that promising studies will be carried to completion, we will have difficulty achieving worthwhile results even in fiscal years 1956 and 1957. Assurance that the program will not be interrupted is needed now if we are to undertake research that will not be completed until after fiscal year 1957. Interruption or abandonment of the program after fiscal year 1957 would, in any event, dissipate a large part of the valuable results already achieved or anticipated, with a consequent loss to the Government.

Since the initiation of the research program under the act of July 3, 1952, excellent cooperation has been received from various organizations. Efforts are continually being made to encourage private development of processes and to interest industrial firms in the problem. The expansion of our basic authorization proposed in S. 516 to permit an expenditure up to $500,000 for research to be conducted in existing Government laboratories would, however, prove advantageous in a number of ways. Several individual scientists have had ideas on processes worthy of at least exploratory research effort but do not have laboratory facilities available. Some would be agreeable to having the research carried out at a Government laboratory but the research has not been carried out because of apparent lack of authority to utilize such laboratories. Government scientists, in some cases, have worthwhile research to propose in which they and their laboratory are best qualified to proceed. Another area in which operations in a Government laboratory would be valuable is in making unbiased comparisons of processes and in confirmation of research results. In some cases, Federal scientific organizations offer the only satisfactory personnel and facilities to conduct certain investigations.

The Bureau of the Budget has advised that there would be no objection to the submission of this report to your committee but that no commitment can be made at this time with respect to the amount of $6 million which the bill, if enacted, would authorize to be appropriated.

Sincerely yours,

FRED G. AANDAHL,
Assistant Secretary of the Interior.

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington 25, D. C., March 2, 1955.

Hon. JAMES E. MURRAY,
Chairman, Committee on Interior and Insular Affairs,
United States Senate, Washington 25, D. C.

MY DEAR MR. CHAIRMAN: This will acknowledge Mr. Stewart French's letter of January 20, 1955, requesting the views of the Bureau of the Budget on S. 516, a bill to amend the act of July 3, 1952, relating to research in the development and utilization of saline waters.

The proposed legislation would amend the existing act by extending the life of the program from 5 years to 10 years for active research with 3 additional years to complete existing research projects and to correlate data and publish results. In addition, this bill would increase the maximum authorization for the program from $2 million to $6 million. Within this authorization the maximum amount for departmental expenditures would be raised from $500,000 to $1,500,000. The amendment further permits the expenditure of not more than $500,000 for work in Federal laboratories.

The Department of the Interior and the National Science Foundation have reported to this Bureau that they consider this to be an important area of research and therefore recommend enactment of this legislation.

The Bureau of the Budget concurs in the views expressed above and recommends that your committee give faborable consideration to this bill.

Sincerely yours,

DONALD R. BELCHER, *Assistant Director.*

STATEMENT OF HON. FRANCIS CASE, UNITED STATES SENATOR FROM THE STATE OF SOUTH DAKOTA

Senator CASE. Mr. Chairman, with your indulgence, I would like to talk informally.

Senator ANDERSON. I think it would be fine if you would do that.

Senator CASE. Thank you, Mr. Chairman.

S. 516, as I am sure the committee knows, is a bill to carry forward the program authorized by the act of July 3, 1952, authorizing research in the development and utilization of saline waters. The chairman of this committee has a great deal of background on this whole subject of water. He was one of the Senators who was interested in the adoption of the act of July 3, 1952. He was most helpful on the floor in its passage and in getting funds to implement the act.

Research into the development and utilization of saline waters has been going forward under provisions of the act, very well. But we did not start too soon. Last year I was at the White House on two different occasions when I heard the President of the United States say that he regarded the increase of our water resources as the most important problem we have. He described water as the most critical natural resource that we have.

Yesterday, the Chief of Engineers, Gen. Samuel D. Sturgess, appeared before the Committee on Public Works, and made the statement that our use of water in this country has increased by 4 times in the last 50 years. Someone asked, "What does that mean on a per capita basis? The population has gone up, and naturally it would increase." The answer is that the population has gone up about twice, and we are using twice as much water per capita as we did. So, water demand, whatever the cause, is twice what it was at the opening of the century.

Senator ANDERSON. Did he anticipate a continuing growth in the utilization of water?

Senator CASE. He did. Regardless of whether we have a per capita increase or not, if total demand increases 4 times in 50 years, and we are dealing with an exhaustible resource in certain areas and a dwindling resource in other areas, the importance of research in devices to recover used water or to increase the supply of water by conversion of brackish water becomes self-evident.

Senator ANDERSON. Before whom was this testimony?

Senator CASE. The Committee on Public Works. It was a statement on the total program of the Corps of Engineers, opening a series of hearings on flood control, river and harbor projects.

Senator ANDERSON. Senator Case, has it not been your experience, living a long time in the West, that a great many industries in the West can look forward to development only if water supplies keep pace with technoligical developments?

Senator CASE. That is certainly true. It is not merely only in the West, but in the Middle West and the East. The growing demand of water for industrial uses means that in many places that thought they would never worry about water they are worrying greatly.

Senator ANDERSON. If it is true in the West, is it not equally true on both coasts?

Senator CASE. I think it is. At this point, I want to bring to the attention of the committee an engineering publication entitled "Power" of the McGraw-Hill Publishing Co., and the special report on water to which the number of September 1952 was devoted. This number is stimulating to anyone who is interested in water. The authors of this report speak of water as a resource which circles endlessly between the sky, the land, and the ocean and back to the sky through transpiration and evaporation.

I asked yesterday that copies of it be gotten and supplied to all members of the Committee on Public Works. I think members of this Committee on Interior would also find the report of considerable interest.

I am not going to burden the record with reviewing it at this time, but I suggest that it is very significant when this well-known firm in the engineering world devotes an entire publication to the need for conserving and increasing the recovery of water and describes the ways in which those goals can be approached.

Among the important means that it suggests, incidentally, is the recovery of water from the ocean.

Senator ANDERSON. Were you able to get copies of this for the members of the Public Works Committee?

Senator CASE. I do not know whether we will get extra copies or not. I brought my file copy along for illustrative purposes this morning.

You will note this schematic design suggesting that the supply of water which existed at the beginning of the world has moved endlessly between sky and land, works through the soil and then by runoff or evaporation or cropping gets back to the sky.

The rain portion of the cycle suggests development along another line in which the chairman and I have been interested; that is the possible modification of clouds. That, we agree, has important potentialities. For our immediate concern, however, I call attention to the space given in this report to the possible recovery of saline waters.

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In my own thinking the possibilities in this field include not merely ocean waters, but also naturally brackish waters in the United States, and the waters which have been contaminated by mineral salts deposited through industrial uses.

And this broad field is the one in which research was authorized by the act of July 3, 1952, which we seek to extend with the bill S. 516. Congressman Engle, of California, has a companion bill in the House.

Following the adjournment of Congress last summer, a number of the Members of the House who have been interested in this program and I went to Boston with Mr. David Jenkins of the Department of the Interior, who has been in charge of this research program. There we saw two of the experimental projects getting underway.

First we saw the field unit that is to try out the ionic process on waters in Arizona and in South Dakota. That was most interesting. My interest in this field was first attracted to the possibility that we might run water through synthetic resinous membranes and by the application of electricity during the filtration break out the salts and get a recovery of good water that would not be beyond the cost that municipalities could pay for domestic use.

Such information as I have would indicate that that research is succeeding in that direction. These membranes are built up in a stack or column with offsetting holes in them. As the water goes between the membranes, and then passes on through, ionic separation takes place. As I recall, they get a recovery of about two-thirds fresh water and one-third sludge, or it may be the other way around. At any rate, it is a very interesting process and not too expensive for moderately hard water. I hope when the results come from the field, where the unit is now at work, that we may have a solution for the many small towns and larger municipalities who have long been plagued and handicapped with brackish waters, unfit for boilers and unpalatable for human consumption.

Somewhat to my surprise, I was even more intrigued by a new experiment I saw underway in Boston at the Badget Co. that seems to me to have even greater potentialities in desalting water from the ocean. Dr. Hickman has created a device which utilizes several physical laws in the distillation of water at low temperature by whirling thin layers of water in a vacuum. This inventor-scientist had taken the motor out of an old vacuum cleaner and used it to spin a couple of disks inside a sealed vacuum. The inside of the housing showed disks like a couple of frying pans spinning by the revolving shaft in the center. He induced the water into the vacuum and sprayed it on outside of the whirling frying pans in a thin film. This gave the advantage of quick explosion of the water, the same as when you simply wet your finger and put it on a hot iron. The water boils almost instantly and goes off as steam. By doing this under a vacuum the heat required is very little and largely comes from the centrifugal force. The result, of course, is a steam drawn into a condenser and you have distilled water.

My recollection, and here again I leave it to those who might have taken notes on it, that this offers a prospect of getting distilled salt-free water out of the ocean water at a cost of about $100 per acre-foot, or approximately 30 cents a thousand gallons.

If that goal can be achieved, the significance of that is almost beyond imagination for coastal cities. Any city can certainly pay 30 cents a thousand gallons for municipal water.

Senator ANDERSON. Senator Case, you have been very much interested in this for a long time. Do you not see the possibilities that if this process might work, or some equivalent process might work, that we could cure a great many of the squabbles that are going on in this country now with reference to possession of water?

Senator CASE. I think we may well do that very thing and save billions of dollars.

Senator ANDERSON. I am thinking of a bill that is now on the Senate floor on the upper Colorado project. The opposition to it is pretty largely based on the fear of the city of Los Angeles that it may lose a water supply very essential to its future growth. Whereas, if it was able to take the sea water that lies within its boundaries it would have an unlimited supply of water and could turn back to the Colorado River the water which it is now using, thereby changing the position of all of these States involved in this controversy, including the States of Nevada and Arizona, particularly, in the lower basin, and all of the upper basin States, because of the 5 million acre-feet now being used in California being able to be obtained from the sea. Then the waters of the Colorado River are more than ample for all the development that was originally contemplated.

Senator CASE. That is certainly true. I do not wonder that California is concerned, because I believe that two-thirds of their population lives in the part of the State that receives about a third of their rainfall. But the various projects that are proposed to bring water to that area run into billions of dollars. Our bill here suggests a research program of possibly $6 million. If it were successful in achieving a process which will answer the water problems of South California alone, the Federal Government would receive dividends that would run 1,000 percent.

Senator ANDERSON. The Federal Government could afford to pay a billion dollars to have this water available in one spot alone in this country, to say nothing about all the other spots in the country that would be in a wholly different situation if they were able to do this. Of course, there would be an enormous saving, would there not, in the construction of every vessel that traverses the seas. There would be enormous savings in a ship like the *Nautilus* which has to make potable water out of sea water. If a simple process could be developed, it would reduce the cost very materially in the future.

Senator CASE. It would reduce the cost and increase the payload. If a ship has to carry water with it, it loses the payload that it can carry.

Senator ANDERSON. So what the Senator from South Dakota is seeking in this bill is not any narrow advantage to any particular section of the country, or any narrow advantage to any particular industry, but it is of importance to every section in the country and every industry in the country.

Senator CASE. That is correct. I appreciate the able chairman's statement in that regard.

There is just one additional point I would like to make. This is a research program. There was a tendency in the Appropriations Committee at one time to think that the proponents should be able in advance to say this is the particular project we want to work on, or that is the particular project. But this program includes broader or more basic research than that. The responsibilities that rest upon the people who carry out this program, it seems to me, are

such that it should give them free rein to consider new proposals and to follow where their research may lead them. I have mentioned only 2, but I understand that some 500 research proposals of one sort or another have been received.

When we were discussing this program before the first legislation was enacted, I referred to a news item I had seen that some Swedish inventor had a different process. That is one of those now being studied. I believe more than a score of research and development contracts have been made, and all of them are on a different approach. Some of them would use solar energy. Some of them may use the reverse osmosis process. Some of them would use the extraction process.

If the job is to be done, the committee should have sufficient funds to pursue research or grant research contracts along any line which seems to offer promise after it has been evaluated. I said I understood over 500 proposals had been made. It does not mean that they have to pursue every one of those to the ultimate goal, because some of them can be classified and judged in relation to something they have learned in the programs already established. But the agency ought to have sufficient funds so that they can pursue everything that offers any promise in this very important field.

Senator ANDERSON. Would the Senator from South Dakota permit me to suggest that that is exactly what is being done in other programs now under way. The Atomic Energy Commission announced a few days ago that it had received four proposals for building reactors on the basis of its new program. It took bids up to April 1, and it got four offers. Each one of those four offers is for a different type of reactor. One is for a boiling water reactor, one is for a pressurized water reactor, one is for a swimming pool type, and one is for sodium graphite. They did not say they are going to spend hundreds of millions of dollars on these things, not the Commission, but private industries; they didn't say try the boiling water reactor and nothing else; and they didn't say try the sodium graphite reactor and nothing else. They said each one of you try something a little different. We like that.

Then along came private industry, and they said we don't want the Government help because we want to try something that is so revolutionary that perhaps the Government would not want to put any money in it.

Is that not somewhat parallel to what you have been suggesting here, that they not try one process, even though this Swedish process 2 or 3 years ago seemed to be the most promising, but try various processes?

Senator CASE. I am glad for the illustration the chairman has proposed. I would like to ask him, too, because of his chairmanship also of the Joint Committee on Atomic Energy, whether or not some of those programs or proposed processes for the application of atomic energy do not of themselves involve potentially large uses of water.

Senator ANDERSON. Enormous quantities of water.

Senator CASE. And for that reason this water program might make a contribution also to the development of atomic energy on a practical basis.

Senator ANDERSON. Yes, I think there is no question of that. Particularly I think because there are areas that are high cost areas

for electric energy which would seem to offer the greatest possibility for returns from atomic energy plants, Almost always, however, those high cost areas seem to be located at spots where water is not too prevalent. Therefore, you come back to the same question which you pose; we ought to be able to use the water resources we have in those areas.

Senator CASE. Mr. Chairman, just in conclusion, may I offer this thought. There are some programs that we have that seem to offer benefits for a particular class of people or for a section or area, as you have suggested. This program, however, has potential benefits all across the country. It offers hope to the rancher living in an area where the only well water he can get is alkali and brackish and poor water for his stock to drink, poor water for his wife to use in her laundry and household uses. It offers advantages for the small towns that have iron in their water, or magnesium or sulfur; it offers a way for them to get water that will do away with water softeners and make better living possible for people living in those towns. It offers potentialities for the small city that wants to develop industrially, but does not have an adequate water supply, and has to reclaim water when it is used industrially. It offers potentialities for the larger cites along the seacoast that have the tremendous problem of an adequate supply for a growing industrialization. You, Mr. Chairman, have now suggested that it offers possibilities for contribution to this great field of atomic energy. So, Mr. Chairman, this is one bill that has no politics in it, no geography in it, no discrimination in it, or anything of that sort. It is a bill of multiple benefits to all our people, and I hope it may be approved.

Senator ANDERSON. I want to add one use that probably my preoccupation with atomic energy might suggest to me, and not anyone else, but I have been hearing what the civilian defense problem might be in case of the dropping of an atomic bomb on this country by a hostile nation. We fortunately have escaped the scars of war in this country but we have to realize that if intercontinental missiles might be developed, or a plane might carry an atomic bomb and drop it, it need not hit a city like New York to cause unlimited damage. If it hit the reservoir above New York which supplies its water, it would immediately put a great city like New York in a frightful position. You could not rebuild that reservoir in a few days.

Senator CASE. Nor replenish the water supply.

Senator ANDERSON. That is correct. But if you had a machine that could turn right to the ocean and pump water into the mains, that will be very effective. I need not say to the Senator from South Dakota, who has been watching the developments on this front, that if an atomic blast should come to this country, the one thing that helps perhaps is to be able to wash frequently and well and make sure that these products that are left around on the ground do not cause damage. The one lesson we learned from the Japanese fishermen was that if they had been able to wash quickly and had done so, the damage would have been minimized. Other people in that area got almost the same exposure as far as hours of exposure were concerned, but they were treated at once by Public Health Service people who became aware of their exposure to fallout, they washed quickly, and did not need anything more than ordinary water to get rid of a great deal of the effects

I think we better make sure we have a water supply in this country if we are going to live in an atomic age.

Senator CASE. I appreciate the chairman's emphasis on that. I was in Nevada recently for one of the tests, and the thing that was stressed in our briefing there was that the best method of decontamination was to wash things down.

Senator ANDERSON. That is exactly right. That is why I say water is so important in this program.

Does the Senator feel that a $6 million appropriation is adequate? Does he think it ought to be increased or diminished, or would he like to have the bill stand as it is?

Senator CASE. Mr. Chairman, on the basis of the start we made on the program, I thought that $6 million was a sound figure to suggest. We started out, as you know, with an authorization for $2 million, spread over a possible 5-year period. We had to start with a very small amount to get the money in the supplemental bill. I think the people who have been working on the program are better able to judge of exact needs than I. I am not familiar with the costs on research projects to give a sound judgment.

Senator ANDERSON. The Senator from South Dakota knows that the only reason we put in only $2 million the other time was because that was all we thought we could get by with. It was not that anyone thought that was going to do the job.

Senator CASE. We had to be modest in order to get a hearing.

Senator ANDERSON. It may be true again that we will have to be modest in order to get a bill of this nature through.

Senator CASE. Mr. Chairman, the figure of $6 million will hardly do all the job that ought to be done. If we can increase the total and tackle the larger problem, a limitation perhaps, ought to appear in the amount that is used in this correlation between research and development in Federal laboratories, and that which is undertaken by contract.

Senator ANDERSON. I notice in line 17 that it puts nor more than $500,000 to be expended for research and development in Federal laboratories—$500,000 does not mean anything in a research project any more. It is a rather small sum of money if you start to step it up into a sizable program. I do suggest that not only the development of the hydrogen bomb, so-called, but also the development of the whole arsenal of weapons that are completely different from any we have used, and the indication at least that other nations are going to have similar weapons, would certainly make it desirable to speed this up as much as possible.

Senator CASE. Does the chairman know to what extent the Appropriations Committee is currently going into the amount that can well be used in any given year?

Senator ANDERSON. I have no knowledge on that subject. I am only suggesting to the Senator from South Dakota that it might be well—and before we finally come out to report the bill—if he would look again as to the limitations that were put in as to overall amounts, and the amounts that might be used in a single year. It might be well to put a specific provision in there for cooperation between the Office of Civil Defense and the Atomic Energy Commission, because I think that water is one of the few things that can be useful in case of atomic attack on this country.

Senator CASE. Of course, what the chairman is pointing out there is important, namely, the coastal cities are for several reasons likely to be more subject to attack than some interior cities, because of the possible approach by submarines launching atomic devices, the possible egress and ingress of materials, supplies, troops, ships, and so forth, through the harbors, so that the need for a fresh water supply may become increasingly important at coastal cities. The cities who might most readily replace a supply if they could convert saline waters would be those coastal cities.

Senator ANDERSON. I am only trying to say that when the first discussion came up on this proposal, and when the Senator from South Dakota put together a bill that Congress passed, it had no knowledge of how quickly we might be in a hydrogen age, and it had no knowledge that our relationships in other parts of the world might deteriorate as rapidly as they have. I think that the development of these new weapons does somewhat change the urgency of this bill.

Senator CASE. I think it does. The Bureau of the Budget made a favorable report on the bill as it is before the Senate, did it not?

Senator ANDERSON. Yes. It might be desirable to leave it as it is. But I think if we change some language in it to permit more rapid expenditures of money, if there is a feasible way of spending it, then it might not be a bad idea.

Senator CASE. I assume, of course, the committee will take some testimony from the people handling the project on that score.

Senator ANDERSON. Yes. Thank you very much.

Senator CASE. Mr. Chairman, I thank you.

Senator ANDERSON. Mr. Frye.

STATEMENT OF ED FRYE, FOR FRED G. AANDAHL, ASSISTANT SECRETARY OF THE INTERIOR

Mr. FRYE. Mr. Chairman, I have a statement prepared for Assistant Secretary of Interior Aandahl. He could not be here, and asked that I be permitted to read it.

Senator ANDERSON. Very well. You may proceed.

Mr. FRYE. The departmental report recommending passage of the proposed legislation which was submitted by my letter of February 16 gives considerable detailed information on various aspects of the saline water conversion program. At this time I would like to discuss briefly the departmental policy regarding this work, and then, with your permission, ask Mr. Jenkins, director of the program, to report on the actual operation of the program, including its technical phases.

I would like here to say that good progress is being made in the development of practical, low-cost means of desalting sea and other saline waters. The advisers to the Secretary of saline water conversion have from time to time reviewed the program and the progress being made and statements submitted by eight of them favor the proposed legislation. With your permission I have copies of those letters which I submit for the record.

Senator ANDERSON. Those may be inserted in the record at this point.

(The information referred to follows:)

MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
OFFICE OF THE PRESIDENT,
February 16, 1955.

Mr. FRED G. AANDAHL,
Assistant Secretary of the Interior,
United States Department of the Interior,
Office of the Secretary, Washington 25, D. C.

DEAR MR. AANDAHL: I am glad to express my concurrence with the proposal that Congress be requested to extend the Saline Water Act for a period of 5 years. It is important that there be a sustained program of research and development if we are to come up with new developments, and the extension of the act will help to accomplish this.

Yours sincerely,

J. R. KILLIAN, Jr., *President.*

THE UNIVERSITY OF WYOMING,
OFFICE OF THE PRESIDENT,
Laramie, Wyo., January 7, 1955.

Mr. FRED G. AANDAHL,
Assistant Secretary of the Interior,
Department of the Interior,
Washington 25, D. C.

DEAR MR. AANDAHL: I agree with your proposal that it would be a good idea to extend for another 5 years the Saline Water Act of 1952 which expires July 15, 1957. I am of the opinion that considerable progress has been made and if the project is not extended much of the effort which has been expended would be lost.

Please call upon me if I may be of any service to you in securing passage of legislation extending the original Saline Water Act.

Sincerely yours,

G. D. HUMPHREY, *President.*

ABERDEEN AMERICAN-NEWS,
Aberdeen, S. Dak., January 7, 1955.

Mr. FRED G. AANDAHL,
Assistant Secretary of the Interior,
United States Department of the Interior,
Office of the Secretary, Washington 25, D. C.

DEAR MR. SECRETARY: I have your January 4 letter and am in complete accord with the decision to recommend that the Congress be requested to extend the present Saline Water Act of 1952 for a period of 5 years.

It is my personal observation that more and more people have become aware of the water shortage looming in various sections of the United States and it seems to me that this problem now has become a paramount one which must be resolved.

With kindest regards,

Yours very truly,

HENRY J. SCHMITT,
Editor and Publisher.

THE UNIVERSITY OF CALIFORNIA,
January 31, 1955.

Re Saline Water conversion program

Mr. FRED G. AANDAHL,
Assistant Secretary of the Interior, Department of the Interior,
Office of the Secretary, Washington 25, D. C.

DEAR MR. AANDAHL: In reply to your letter of January 4 concerning a 5-year extension of the Saline Water Act, and following a conference with Prof. Everett D. Howe, it would seem to me that the progress of work to date and the prospect of getting significant research fully under way would warrant the proposed extension.

It was a source of satisfaction to learn that you also believe that results obtained thus far are sufficiently encouraging to indicate that economical conversion will be developed, provided research and development activities are given a reasonable

time in which to cope with this significant problem. While some may be deluded into believing that research is simply a process of waving a magic wand, or its results can be assured merely by the size of appropriations or the urgency of deadlines, I am happy that there are those who realize that it is a human process warranting not only the economical marshalling of the best brains of the Nation, but also requiring careful programing, precise knowledge of developments, and many tedious man-hours of the most exacting type of human endeavor—spurred by faith in the promise of results and not by any guaranty, man-given or otherwise.

I commend you and your colleagues for the recently completed mission to inspect research and development in water conversion throughout Europe and Northwest Africa, and I am happy that our Professor Howe was privileged to participate as a member.

Yours sincerely,

ROBERT GORDON SPROUL,
President of the University.

BALTIMORE 1, MD., *January 10, 1955.*

Mr. FRED G. AANDAHL,
Assistant Secretary of the Interior, Saline Water Conversion Program,
United States Department of the Interior, Office of the Secretary,
Washington 25, D. C.

MY DEAR MR. AANDAHL: It is with interest and satisfaction that I note that it is the intention of the Department of the Interior to recommend to the Congress the extension of the Saline Water Act of 1952 for a period of 5 years.

To suspend this work late next year would, in my opinion, be a serious setback to the solution of this problem which is vitally necessary to the future welfare of the Nation. Each year water shortages in parts of our country, as well as elsewhere in the world, increase in gravity. In many cases converted saline water appears to be the only remedy for these conditions.

For many years desalting of water in arid or semiarid regions has been discussed pro and con. Usually, comments or proposals have lacked in practicable application and often have been oblivious to the vital matter of cost of production.

In my judgment, the Department of the Interior has approached the problem in a realistic manner and has developed methods of attack which will in time prove successful. Few who have seriously thought on this problem will minimize the difficulties which must be overcome or the time which will be required to find a satisfactory answer, but it is equally true that few will doubt that the time will come when water from this source must be widely used in our country.

I am sure that many will join with me in the hope that this program will be placed on a permanent and continuing basis.

Sincerely yours,

SHEPPARD T. POWELL, *Consulting Engineer.*

SOUTHWEST RESEARCH INSTITUTE,
San Antonio 6, Tex., January 6, 1955.

Mr. FRED G. AANDAHL,
United States Department of the Interior,
Office of the Secretary, Saline Water Conversion Program,
Washington 25, D. C.

DEAR SECRETARY AANDAHL: I have your letter requesting comments on the proposed extension of the Saline Water Conversion Program Act for an additional 5 years.

In the chemical industry it is generally accepted that the average time from conception to marketing of a new product is approximately 7 years. For the more complicated or advanced products or processes the development time is of course even longer. The saline water program is developing a major new chemical process in an extremely difficult field and it is only to be expected that more than 5 years will be required.

In July 1953 in one of my speeches on saline water conversion, I estimated that it would take 5 years to develop processes economically useful on brackish waters and to determine whether or not sea water reclamation would be feasible—also that if proven feasible it would then take another 10 years before sea water conversion plants were in successful operation.

In another speech first given in July 1954, I indicated that progress had been better than previously anticipated but that it would still be 3 to 4 years, i. e., 1957–58 before feasibility were shown. Transcripts of both of these talks with the pertinent passages marked in red are enclosed.

Although the progress in the last 6 months has been satisfactory there is nothing to indicate that this time schedule can be appreciably shortened. This means that by the end of the present act, we will probably know whether sea water reclamation will ever be feasible. It will then take us at least the additional 5 years requested in order to fully develop a feasible process.

I do not believe that the legislature can question the amount of research expenditures under the act. Actually out of every $14,000 spent annually for research and development in the Nation—only $1 goes for the research effort of the saline water program. Or to put it another way, out of every $9,000 spent by Government agencies for research and development only $1 is spent on the saline water conversion research effort. This despite the judgment of many that, after defense, water is the No. 1 problem in the Nation's welfare.

Cordially yours,

LOUIS KOENIG,
Associate Director.

PURDUE UNIVERSITY,
Lafayette, Ind., February 15, 1955.

Hon. FRED G. AANDAHL,
Assistant Secretary of the Interior,
Washington, D. C.

MY DEAR MR. SECRETARY: I have discussed the saline water research program of the Department of the Interior with various members of the Purdue University staff. I join them in the opinion that this program has been a most worthwhile one and that it would be highly desirable to continue the research beyond the present expiration date of the act supporting this program. The gradual diminution of our basic water resources poses a serious future threat to all aspects of our economy. It is self-evident that a vigorous research program concerned with the recovery or production of potable water from both sea water sources and available brackish water sources is one of the most promising methods of insuring adequate future water supply.

There are several current research projects of your saline water conversion program which show promise of bringing at least a partial solution to the problem. In addition, the mere existence of this program serves to call to the attention of the scientists of the country the need for further research in the solution of this most pressing need of the country. The great need for this program is the generation of new ideas. The greatest probability of generating these new ideas is through an active research program. Certainly conservation of water resources through research is an appropriate area for support by the Federal Government.

I should be most pleased, therefore, to go on record as favoring the extension of the present act for a period of 5 years with an additional year to evaluate the results of the research program.

Yours sincerely,

FREDERICK L. HOVDE, *President.*

FEBRUARY 12, 1955.

FRED G. AANDAHL,
Assistant Secretary of the Interior,
Washington, D. C.:

The saline water conversion program is examining all lines of approach to this important problem. Though there are attractive possibilities it is clear that an extensive program of research is still required before practical methods of water rectification can be achieved. I would strongly urge a continuation of the authority for the program with continued careful evaluation of its progress and of proposals for future expenditures.

(Signed) L. A. DUBRIDGE,
President, California Institute of Technology.

Mr. FRYE. Although certain of the legislation proposed prior to 1952 would have provided for immediate construction and operation of a full size sea water conversion plant at a cost of some $25 million,

extensive hearings before this committee during the 1st session of the 82d Congress revealed that processes for the economical production of large quantities of fresh water at low cost did not then exist. Scientists and engineers, testifying at these hearings, established this fact quite clearly. As a result, the Congress concluded that large expenditure of Federal funds would not be justified. Instead, it provided for the development of processes, by means of research grants and contracts.

With this approach scientists and engineers have given their support to the program as is illustrated by the letters which have been submitted for the record, received from Dr. Langelier of the University of California and from Dr. Sherwood of the Massachusetts Institute of Technology. Dr. Langelier states:

> I am favorably impressed with the methods which are being employed by your office in carrying out its assignment. Your initial publication Demineralization of Saline Water is excellent. The treatment of the subject is factual with just enough optimism to encourage the investigator and yet enough pessimism to quiet the unjustified claims which were broadcast about a year ago.

These claims have given the impression that all that was necessary to obtain cheap fresh water from the sea would be to build a large-scale demonstration plant. Dr. Sherwood is here today, to testify as the representative of Dr. J. R. Killian, president of MIT, who is one of the Secretary's advisers on this program.

As pointed out in my report on S. 516, as processes are developed in the laboratory, pilot plants or field tests become necessary in order to obtain operating information, engineering design data, and test results upon which more accurate cost estimates can be made. The cost of such experimental plants varies with the type of process. They can become relatively expensive. For example, in a conversion method proposed by Dr. W. L. Badger, a recognized authority on evaporation, it may be necessary to build a pilot plant which may cost $150,000 to $200,000 in order to solve one major problem—scaling—which is inherent in the process and to verify the economic feasibility of the process as predicted by his analysis.

The solution of difficult technical problems by means of scientific research takes time. The rate of progress cannot necessarily be increased by the appropriation of large sums of money. However, the progress made in the development of saline water conversion methods under this program has been quite rapid. From my own observations and from reports I have received from various parts of the country, I believe that the progress being made under the saline water conversion program is satisfactory and that the encouraging results to date justify amending the original act as is proposed in S. 516.

Senator ANDERSON. I have just one comment on this. If you would read the story of the development of the atom-powered submarine, you would almost recognize some language in here. The rate of progress could not be increased by large sums of money. If certain phases of the Navy had its way, we would not have had the atomic-powered submarine for years. But Admiral Rickover said we will jump these places, although we may come back, and we will start out. I believe in a nice conservative method. I believe we are almost coming to the point where we will have to jump some of the early hurdles and try while at the same time remaining conservative in another type of program. In other words, it is possible to do both

things at the same time—continue to build a sound program, and at the same time take a little gamble to get the supplies of water which I think we will need at the earliest possible time.

STATEMENT OF DAVID JENKINS, DIRECTOR OF THE SALINE WATER CONVERSION PROGRAM

Mr. JENKINS. Thank you, Mr. Chairman. I have a prepared statement for the record of considerable length which I believe is before you. I should like to briefly summarize certain points in that statement.

I would like to say first that although I have been in the Federal civil service since 1929, this is the first opportunity I have had to meet before this committee, and I appreciate the honor of doing so.

We also have, as was mentioned, one other witness, Dr. Sherwood of Massachusetts Institute of Technology, and with me today are the three technical staff members of the saline water conversion program, Dr. W. S. Gilliam, physical chemist, Mr. J. J. Strobel, chemical engineer, and Mr. Allen Cywin, a mechanical engineer. I may wish to call on these gentlemen to answer technical questions.

The need for additional fresh water from the oceans and for improving the many salty waters of our inland States was well established some time ago, and therefore I thought unless the committee especially desired otherwise, I would not repeat those needs, which are even greater today than they were in 1952.

As this is the first opportunity we have had to meet before this committee since the program was organized, it was thought that the committee might like to know a little of the method of operation.

Among the material before you is a chart which I should like to refer to, and first I should like to point out that because the activity was related to several of the Bureaus in the Department, each of which was in a position to make some technical contribution, the responsibility for the program was placed in the Office of the Secretary by former Secretary Chapman.

Then in the spring of 1953, following very careful review, the present administration confirmed that the work could be handled best in the Office of the Secretary, rather than in one of the bureaus, and on October 8, 1953, Secretary McKay assigned the responsibility to the Assistant Secretary for Water and Power Development. It now operates as a part of his office.

In general, the procedures for the program were patterned after the large research organizations of the Government, such as the National Science Foundation and the Department of Defense. We endeavored to take advantage of the experiences gained by those large organizations, particularly since this was a new type of doing business in the Department of the Interior.

Referring to the chart, the group of nine eminent leaders of educational, scientific, and industrial organizations, the advisers, provide the Secretary with advice on broad policy matters. It has been very gratifying to know that of the nine original advisers who agreed to serve in that capacity in 1952, all are continuing to serve at present.

Then on the left of the chart, under coordination, the research is continuously coordinated with private organizations and other Government agencies, including the Department of Defense, in

accordance with requirements of the Saline Water Act, and with the National Science Foundation, with which a cooperative agreement exists. Other governmental organizations are those listed, and the question was asked a few moments ago about cooperation with the Civil Defense Agency and the Atomic Energy Commission.

We have established active cooperation with both, and some of the problems that were mentioned a few minutes ago have been discussed and attempts have been made to reach conclusions with those agencies as to the needs of equipment for civil-defense use, and also the need for and possibilities of the use of atomic energy.

Senator ANDERSON. If you thought I was suggesting the use of atomic energy as a cheap source of power in this, you missed entirely what I was saying.

Mr. JENKINS. No, sir. I understood that you thought that close liaison and cooperation should be maintained with that organization.

Senator ANDERSON. Only because of the possibility of some day an atomic attack by devices which might have atomic warheads, and which very quickly could change the whole picture as to the usability of water now stored in a reservoir or the actual destruction of the reservoir itself. You recognize, I am sure, the dependence of New York City upon its reservoir for its water supply.

Mr. JENKINS. Yes, sir.

Senator ANDERSON. If those could be knocked out as they could very easily by an atomic device, New York City would not be able to exist. It has no other alternative source of water. The possibility of using sea water is a very attractive resource, which I think the Atomic Energy Commission and the Civil Defense office might profitably explore with you.

Mr. JENKINS. We have been exploring that possibility. It has not been possible actually to do anything about it yet. The Civil Defense has advised that they do not have research funds, and we have done what we could in this program to develop better processes that might possibly be used for that purpose.

Then another word or two as to the organization. There is a Saline Water Conversion Committee in the Department which consists of one representative each from the Bureau of Mines, Bureau of Reclamation, and the Geological Survey. The responsibility of the management of the program, of course ,is that of the program director and his staff, but panels of consultants provide very highly specialized scientific assistance in many ways. That group of about 35 or 40 whose names are listed on page 41 of the annual report before you, Mr. Chairman, represent some of the leading authorities in the special fields relating to this activity. It has been a source of considerable satisfaction to me that we have been able to engage people of this caliber.

Senator ANDERSON. Would you mind indicating from this chart which has to do with the contracts now in existence just what contribution you hope to have from these 1955 contracts? The first is Nuclear Development Associates, research of extraction of fresh water from sea water in the super critical state.

Mr. JENKINS. Yes, sir. That is the principle mentioned briefly by Senator Case, which was investigated earlier by the Swedish scientist, Baltzar von Platen, and was considered by this committee in 1951. That process would separate sea water by the use of extremely high

temperatures and pressures. There are several physical advantages. One is that at or above the pressure and temperature referred to as the critical pressure and temperature water has only one state, that is, the gaseous and liquid state are indistinguishable. Salt water behaves slightly differently, considerably above that state, and there a separation takes place without what we know as the loss of the latent head of evaporation.

The second advantage is that at those high pressures and temperatures the heat exchange rates are very, very, high. It is felt that if two problems which confronted the Swedish investigators can be solved, and we believe that at least one of them is now solvable, that process might offer very attractive economic possibilities. Those two problems are corrosion and the formation of scale, in the apparatus. The corrosion we believe is now solvable by the development of improved metals which were not available 15 years ago.

We don't know about the scale formation, and that is the matter that is being investigated under this contract that you asked about.

Unless the scale-formation problem can be solved, we would not go forward with that process.

Senator ANDERSON. What about half the money going to Nuclear Development Associates? Are they particular specialists in the scale problem?

Mr. JENKINS. They are specialists in this particular field of high-pressure and high-temperature distillation. They have carried on quite a bit of work in that field for the Atomic Energy Commission. It is that experience that we draw on.

Would you like to run through the contracts?

Senator ANDERSON. No. I just notice that the next one is to the University of Florida, for the investigation of possible uses of ultrasonics in the mineralization of saline waters, less than $5,000, which seems a pretty small sum of money in the scope of the work that some of us think needs to be done.

Mr. JENKINS. These various contracts range from a few thousand dollars to $90,000, so far, depending on the job to be done. Here a professor at the University of Florida who has carried on a great deal of work in the use of ultrasonics, feels that it is possible to effect a separation of salt from salt water by the use of ultrasonics. He has carried on a little work in his laboratory. All that we are asking him to do here is to prove that it can be done. If he can demonstrate that it can be done with some glassware in the laboratory, and also identify the basic scientific laws which cause this separation, then there will be in order a research and development contract. We usually try to start that way when we are not sure.

Senator ANDERSON. Do you feel that these projects push forward as rapidly as possible the possibility of developing potable water from sea water?

Mr. JENKINS. Senator Anderson, the great problem in this entire program is to obtain new ideas. At the time the program was initiated, it was felt that all of the work in distillation and two or three other means of separating water had been done, and of course the objective here is to bring down the cost. What we need here is more ideas.

Senator Case mentioned that there had been in the neighborhood of 500 different suggestions that have been received. These are ideas.

More than 400 were weeded out rather quickly. The others were worked over very carefully to see whether they were sound, and out of that number some 26 research contracts were let after this group of consultants had examined the proposals very carefully. We still need ideas, however.

In answer to your question, I would say that probably we are not doing everything that could be done to exhaust the ideas in the scientific minds of the country, but we are doing all that we are able to do at present. I expect it would be possible to send more people to visit with the scientific organizations and to spread the information of the need for additional ideas.

Senator ANDERSON. Do you see any urgency about this?

Mr. JENKINS. Yes, sir.

Senator ANDERSON. If there is any urgency about it, then you ought to be doing everything that can be done or asking for enough money to do everything which can be done, should you not?

Mr. JENKINS. I think that under the amendment that we will be able to do all that can be done as far as stimulating ideas is concerned.

Senator ANDERSON. What about testing ideas?

Mr. JENKINS. Yes, we need to test the ideas. Under that amendment, I think we have as much money as we can foresee needs for at present. I would like to repeat that it is ideas that we are short of.

If I may refer to one of the publications before you entitled, "Demineralization of Saline Waters," this dearth of ideas was recognized in the beginning, and on pages 5, 6, and 7 of that brochure, an effort was made to list all of the possible processes and phenomena that might be studied or developed for this purpose. That brochure was sent to several thousand people with the invitation to submit their ideas. That was the source of many of the 500 replies.

Since then a number of efforts have been made to interest people further. We look upon the responsibility in the Department as being twofold. One of stimulating interest in this subject in private industry, and the other carrying on the actual research program with Government funds.

If there are no further questions on the two pamphlets, shall I continue with my statement?

Senator ANDERSON. Yes.

Mr. JENKINS. It was necessary in the beginning to establish some kind of a yardstick by which to measure progress. It was felt that a good beginning basis was to compare the probable conversion costs with the prevailing water prices. In 1952, at the beginning of the program, the cost of converting sea water to fresh water by the best existing processes, but with small units, was estimated at $1,500 an acre-foot, and it was estimated that if much larger plants of this type were built, the cost might be four to five hundred dollars an acre-foot. The price that industries and municipalities and irrigation might pay varies considerably, but the maximum that had been paid was used as a criterion for the first objective of the program, and that was irrigation water at approximately $40 an acre-foot, and municipal water at approximately $100 an acre-foot. It was felt that if we could reduce the costs down in that neighborhood in this first 5-year period, then we would be justified in a second stage.

Those cost criteria were necessary. To me, Mr. Chairman, they have been a little like the subject that was mentioned recently of

attempting to determine the value of the electric light in 1890. If we had attempted to set a cost criterion for what light would cost, we could have compared it only with window glass or oil lamps. That would be true in supplying light where light had already been used. But electric light is used in many places where other light was never used. This program of extracting fresh water from sea water opens the opportunity of providing water where water was never used before in many places in the world. Therefore, these cost criteria must be adjusted as we go along.

I wanted to mention a few of the processes that are under development. One was discussed briefly by Senator Case. Then you asked about the process at Nuclear Development Associates.

The vapor compression distillation, which Senator Case mentioned, was one that was used during the war for many small stills, and we were informed at the beginning of the program that major reductions in the cost of producing water by that process simply were no longer possible. For a few months we accepted that conclusion reached by others in the Government and elsewhere. After the program got underway, it was found that in the past 10 or 15 years essentially no major improvements had been made in what appeared to be the best distillation process.

Accordingly, then, a number of research and development contracts were let in that field, and those contractors include the Badger Manufacturing Co., developing the Hickman still, and Yale University, and the Heinz Engineering Co. The Hickman process, although it is yet in a small scale, we believe may make possible the production of fresh water for about a fourth the cost of distilling the water by the most economical process in use at the beginning of the program. The contract in effect at Badger Manufacturing Co. consists of four parts.

First, we felt that it was necessary to test Dr. Hickman's still, that he had built on his own funds, on sea water. It had never been operated on sea water. After many improvements and expenditures of nearly $10,000, it was made to operate on sea water, and successfully did so. Many of the problems that have been inherent in this vapor compression process were not present in that particular still. One was the formation of scale. There was no scaling whatsoever.

The second part was the construction and testing on a research model of considerably larger size and that has been completed within the past month. That is, the construction of the apparatus has been completed and tests are under way at present.

The third and fourth parts are the preliminary and detailed designs of an actual operating model capable of producing 25,000 gallons of water a day from sea water. Those designs are expected around the first of August. Then, of course, a further contract for actual construction and field testing—pilot plant testing, that is—at a seashore location will be in order for next year.

The electric membrane process, also mentioned by Senator Case, is one which was mentioned briefly to the committee in 1952, and is the result of some laboratory tests that had been made on a small unit in Boston, developed by Ionics, Inc. It was decided to test certain brackish waters from the Midwest on that unit. It was found with numerous assumptions and estimates, because the unit was small,

that it would be possible to improve that particular water, which was only slightly brackish, at a cost of about $16 an acre-foot.

Then after the program was started, that equipment was improved and enlarged, and a subsequent contract for laboratory testing of a larger unit resulted in a much lower cost, using the same assumptions, or about $4 an acre-foot.

A water from Arizona was also tested on the improved equipment. That was about four times as saline as the South Dakota water. It was estimated that treatment of that water would cost about $20 an acre-foot.

Those results were sufficiently promising that it was decided to let a contract with a firm for field testing of a larger unit to work out field problems that could not be foreseen in the laboratory, and to determine the durability, particularly of the membranes in this project.

This is being done under a contract in Arizona and South Dakota. In Arizona, the water is a well water being used for irrigation, containing about 4,500 parts per million or in the neighborhood of at least double that which is recommended for irrigation of any crops. All that can be raised in that land at present are salt resistant crops, such as sorghum, cotton and alfalfa, whereas 15 or 18 years ago specialty crops were raised. If this process is successful, it would appear that high value crops might again be produced in that area.

Research on membranes is being carried out at Brooklyn Polytechnic Institute under the program, and independently by the Rohm & Haas Co. of Philadelphia, Permutit Co. of New York, and Gulf Research & Development. However, we feel that because of the complexity of the membrance research—a field known as organic synthesis—and also the limited number of scientists actually experienced in such work, it would be almost impossible to have too much work going on in that particular field.

The use of solar energy to extract fresh water is also attractive, not only from the standpoint of the low cost of energy, if indeed it is low cost, but from the viewpoint of national conservation of fuels, of course. To be attractive, lower cost equipment of greater efficiency is needed and research is being carried out in an effort to discover ways and means of bringing about improvements in such processes. That research includes basic designs being carried out at the New York University and by a private scientist, Dr. George Lof of Denver, and the possible use of plastics to reduce the cost, being carried out by the Bjorksten Laboratories, at Madison, Wis., and a number of small-scale experiments by the University of California.

Other processes that were suggested originally under this program and not worked on before for this purpose, and on which considerable success is being achieved are the osmotic processes being developed at the University of Florida and University of California at Los Angeles. Still a different adaptation of this process has been suggested by Dr. Murphy of the State University of New York. Dr. Murphy has been working, Mr. Chairman, under an exploratory type of contract in which we really employed him to think about this subject. As a result of about a year and a half of study, of all of the processes, he has now suggested one which is different from any before, and which has potentialities.

Then there is a solvent extraction process being studied at the Texas A. and M. Research Foundation. The separation of salt water

by freezing is being studied at the Applied Science Laboratories at State College, Pennsylvania, and at the University of Washington at Seattle.

In my prepared statement there was also mentioned the need for the extension of the legislation at this time. Under the provisions of the present act all of the actual research under the contracts and all reports and all correlation and coordination of data must be completed by July 15, 1957. That opinion was rendered by the Solicitor of the Department of the Interior, and it simply meant that contract research would have to be concluded just about the time we reached into the better, more interesting and productive part of this program. With your permission I should like to submit for the record a copy of that Solicitor's opinion.

Senator ANDERSON. Very well.

(The information referred to follows:)

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SOLICITOR,
Washington 25, D. C., November 23, 1954.

Memorandum

To: Director, Saline Water Conversion Program.
From: Acting Solicitor.
Subject: Limitations on funds—Saline Water Act.

Your memorandum of October 22 requests my opinion as to the legality of contracting for the performance of services pursuant to the act of July 3, 1952 (42 U. S. C. sec. 1951 et seq.), when such services would extend beyond the 5-year period prescribed in section 8 of the act.

You have advised that:

"* * * The contract research for which these funds [appropriation made pursuant to the act] are used each year is for work performed over a period usually extending beyond the end of the fiscal year in which the contract is executed. The term of such contracts averages about 1 year but in some cases may be 2 or 3 years. Thus funds appropriated during the final and fourth year of the program would ordinarily be used for research some of which would be performed subsequent to July 3, 1957."

Section 8 of the act of July 3, 1952 (42 U. S. C. sec. 1958), reads as follows:

"There are authorized to be appropriated, from any funds in the Treasury not otherwise appropriated, such sums, not to exceed $2,000,000, for a five-year period, to carry out the provisions of this Act: *Provided*, That departmental expenses for the correlation and coordination of information over such five-year period shall not exceed the sum of $500,000: *Provided further*, That such departmental expenses shall be scheduled in equal amounts for each year of such period insofar as practicable."

Although this section speaks in terms of authorizing appropriations, its purpose clearly is to limit the amount that may be appropriated and the period of time during which such appropriations may be made and expended. The phrase "for a five-year" period relates not only to that period of time for which sums appropriated may be expended for services under research contracts and grants, but also to that period of time for which payments may be made for work performed by departmental employees on such activities. It is my view that contracts should not be entered into pursuant to the act which would extend beyond the 5-year period. Furthermore, it appears that such contracts should call for the termination of work and the submission of reports thereunder a sufficient time in advance of the expiration of the 5-year period for the Department to perform the correlation and coordination work within such 5-year period.

Because of the view expressed above, we should also answer the question "When does the 5-year period begin?" so that its termination may be known. I believe that such period must be construed as beginning with the date that appropriations were first made pursuant to the Saline Water Act and not from July 3, 1952, the date on which that act was approved. The limitation of the 5-year period is directly related to and contained in the appropriation section of the Saline Water Act as distinguished from its functional provisions. The first appropriation for the purpose of carrying out the provisions of the Saline Water

Act, in the amount of $125,000, was made by the Supplemental Appropriation Act, 1953, approved July 15, 1952 (66 Stat. 637, 642). It is my view that the approval date of that appropriation act, July 15, 1952, must be considered as the date on which the "5-year period" was initiated.

J. REUEL ARMSTRONG, *Acting Solicitor.*

Mr. JENKINS. Mention has been made of the need for research in existing Government laboratories. The provision in the proposed amendment to permit the expenditure of up to $500,000 for research to be conducted in existing Government laboratories would prove advantageous in a number of ways. Several individual private scientists in private life have ideas on processes that are worthy of at least exploratory research but they don't have laboratory facilities. Some would be agreeable to having their research carried out in Government laboratories, but in the absence of specific authority, that has not been done. Then there is a situation, occasionally, when Government scientists themselves have worthwhile research to propose, and we have received at least one quite worthwhile proposal from the Bureau of Reclamation for a practical freezing process to be used making use of the low temperatures in South Dakota, in demineralizing some of the waters there.

Then still another area in which operations in a Government laboratory are valuable is in making unbiased comparisons of processes and confirmation of the research results.

I should like to say that in addition to the work in the United States, work is being coordinated with similar work abroad, and it is believed essential that every scientific improvement or facility to solve the problem should be used and brought to bear regardless of where that ability might be. Program scientists and consultants are obtaining technical assistance from abroad, both by correspondence and personal visits, and it is planned to continue such exchange of technical assistance and cooperation where such cooperation would be clearly of advantage to the United States.

In my prepared statement I had a short discussion of the subject of the use of atomic energy because of the fact that considerable mention has been made in the press from time to time of the possibility of using atomic energy to convert sea water. Through the cooperation of the Atomic Energy Commission this subject has been explored. I should like to refer you to page 24, Mr. Chairman, of the third annual report, in which the joint conclusions of the Atomic Emergy Commission and the Department of Interior in this respect have been set forth. I should like to place these into the record, with your permission.

Senator ANDERSON. Could we not just have them inserted in the record?

Page 24, the entire item starting with "Atomic Energy Commission." That will be done.

(The information referred to follows:)

ATOMIC ENERGY COMMISSION

In view of the extensive research that is carried on by the Atomic Energy Commission in numerous fields, some of which might bear upon the demineralization problem, direct liaison is carried out between the saline water conversion program and the Commission. As a result of that liaison the following conclusions have been reached:

(1) Direct use of nuclear fission for separation of salt from water is not foreseen at this time.

(2) Either heat or electrical energy produced by reactor plants could be used in various demineralization processes. However, as this energy is now no less costly than that from conventional sources, there appears to be no advantage in considering its use for this purpose at this time.

(3) This source of energy should be used in any established demineralization process only if its gross cost allocable to the process is less than the cost of other available energy at the site.

However, either the reduction of cost of energy from reactor plants which may be achieved in the rapidly developing program of industrial uses of nuclear energy, or the successful development of vastly improved demineralization processes could modify these conclusions significantly.

Liaison with the Atomic Energy Commission is being continued.

Mr. JENKINS. It was hoped that representatives of the Atomic Energy Commission might attend this hearing. We discussed the matter with them yesterday and were advised that if the committee wished to request someone to appear they would, of course, be glad to do so.

Thank you, Mr. Chairman.

(The statement referred to follows:)

STATEMENT OF DAVID S. JENKINS, DIRECTOR, SALINE WATER CONVERSION PROGRAM

Mr. Chairman and members of the committee, my testimony consists of factual information on saline water conversion, for your use in consideration of the proposed amendment S. 516 to the Saline Water Act of 1952.

The need for additional fresh water throughout the world and the need for removing some of the salinity of many of our inland streams and underground waters was thoroughly established by this committee and other committees of the Congress prior to enactment of Public Law 448. Therefore, unless the committee especially desires otherwise, I shall not again discuss those needs, which are even greater today than they were in 1952. Instead, my remarks pertain primarily to process development and the present program.

I. ORGANIZATION OF PROGRAM AND METHODS OF OPERATION

Because the activity was directly related to several of the bureaus in the Department, each of which was in a position to make some technical contribution, the responsibility of the program was placed in the Office of the Secretary by order of former Secretary Chapman on December 16, 1952. Then in the spring of 1953, following a careful analysis of the activity, the present administration confirmed that the work could be handled best in the Office of the Secretary rather than in one of the bureaus, and on October 8, 1953, Secretary McKay assigned the responsibility to the Assistant Secretary for Water and Power Development. It now operates as a part of his office.

Referring to the chart appended to this statement: A group of nine eminent leaders of educational, scientific, and industrial organizations provide the Secretary with advice on broad policy matters. The advisers provide this service without cost to the Government, except for occasional travel expenses. Of the nine original advisers all are continuing to serve. They are:

Dr. Robert G. Sproul, president, University of California, Berkeley
Dr. Lee A. DuBridge, president, California Institute of Technology
Dr. George D. Humphrey, president, University of Wyoming
Dr. Louis Koenig, associate director, Southwest Research Institute
Mr. Henry J. Schmitt, editor and publisher, Aberdeen, S. Dak., American-News
Mr. J. J. Cronin, vice president, General Motors Corps.
Dr. Frederick L. Hovde, president, Purdue University
Mr. Sheppard T. Powell, consulting engineer of Baltimore, Md.
Dr. James R. Killian, Jr., president, Massachusetts Institute of Technology

A two-day meeting of the advisers was held in April 1954. Their recommendations made at that time appear in the appendix to this statement.

A Saline Water Conversion Committee (departmental); consisting of one representative each from the Office of the Assistant Secretary for Water and Power Development, the Bureau of Reclamation, the Bureau of Mines, and the Geo-

logical Survey; provides advice and assistance in such matters as development and review of the program, exchange of information, and preparation of the annual reports.

The research is continuously coordinated with private organizations and other Government agencies, including the Department of Defense in accordance with section 3 of Public Law 448, and the National Science Foundation with which a cooperative agreement exists. Other governmental organizations with which cooperation has been established include the Atomic Energy Commission, the Smithsonian Institution, the Federal Civil Defesne Agency, the Department of Agriculture, the Department of State, the Foreign Operations Administration, and the Department of Commerce.

The responsibility for the management of the program including both the coordination activities and the direction of the widely diversified contract research is that of the program director and his staff.

Panels of consultants provide highly specialized scientific assistance in such ways as evaluating proposed research and final results, making technical analysis of existing processes and numerous others.

At present all the actual research and development is performed by the contractors.

This organization has proved adequate except for some difficulty in obtaining qualified scientific assistance in this highly specialized work, as is necessary to supervise the contract research, assure continuing interest and a flow of new ideas which are still very much needed, and handle the technical and administrative actions in connection with dispersed research of this kind.

II. PROGRESS

At the beginning of the program, the cost of converting sea water to fresh water by the best existing processes—the distillation process with relatively small units—was estimated at about $5 a thousand gallons, or some $1,500 an acre-foot, and it was estimated that if much larger plants of this type were built, also using existing principles, the cost would be $1,25–$1.50 a thousand gallons ($400 to $500 an acre-foot).

Two arbitrary cost criteria were set for the initial phase of the program, one for water for municipal and similar purposes at about $100 to $125 an acre-foot, and one for irrigation water at about $40 per acre-foot. They were believed, on the basis of data then available, to represent about the maximum that could be borne by these types of use in continental United States. It was felt that if these goals could be approached or reached, further intensive research and development would be justified to reduce costs. Although considerable work remains to be done before those initial goals are fully realized, they are being approached and it is believed will be materially lowered if the research, and particularly the development work, is continued.

Because this disparity between the existing costs and the objectives was very large, and because improvements in the few existing processes had almost ceased to occur, it was necessary in the beginning to consider every possible solution to the problem, however remote the chances of success might seem originally. The first step was the preparation of as nearly complete an outline of possible processes as could be conceived, as shown in the brochure entitled "Demineralization of Saline Waters," pages 5, 6, and 7. It will be seen that most of the conceivable physical (p. 5), chemical, and electrical processes (p. 6), and energy sources needed therefor (p. 7) are listed. Those pages and the introductory matter thereto on pages 1–4 of the brochure are included in the appendix to this statement.

This brochure was sent to several hundred scientific organizations and individuals believed qualified and interested in considering the subject, with the request that proposals for scientific research in accordance with the outline, or on any other processes not included there but relating directly to saline water conversion be submitted. It was recognized that eventually some processes would be eliminated as unfeasible, some would be developed through various stages, and in some no interest might exist, yet they should be explored.

No single process will provide fresh water for all purposes at all locations and under all circumstances. Thus it is desirable that several different principles, processes, and combination of processes be investigated and developed concurrently. Furthermore, it would certainly not be desirable to place all reliance on 1 or 2 processes to the exclusion of others when none has so far reached the final low cost necessary.

Good results are being obtained, and it now appears that in time conversion of both brackish and sea water will be feasible. Twenty-four research and development contracts have been let, several have been completed, and 7 or 8 very promising results have been obtained. One process is being field-tested, and 1 or 2 others show sufficient promise to justify field tests in a year or earlier. A list of the 26 contracts which have been let, and of some prospective future contracts, is attached to this statement.

At this time a few of the more outstanding processes being developed under the program can be summarized.

Vapor compression distillation

At the beginning of the program it was the consensus of those most familiar with vapor compression distillation development that major reductions in the cost of producing water by this process were no longer possible. After the program got underway it was found that during the past 10 years essentially no major improvements had been made in this—the best existing process, and that new approaches to the problem might result in substantial cost reduction.

Accordingly, a number of research and development contracts have been undertaken under the program for research on various aspects of the vapor compression distillation process. The contractors include the Badger Manufacturing Co., Yale University, Heinz Engineering Co.

The possibilities of obtaining fresh water from sea water at a price which might be afforded by municipal or industrial users have been greatly enhanced by the development of the Hickman still. Although yet in its infancy, this process, being investigated by contract with the Badger Manufacturing Co., of Cambridge, Mass., may make possible production of fresh water from sea water for about one-fourth the cost of distilling sea water by the most economical process in use at present. Field tests at some seashore locations are being planned.

Research under the direction of Profs. Barnett F. Dodge and Harding Bliss at Yale University also seeks to bring down the cost of vapor compression distillation by increasing heat transfer rates in the evaporation units. The approach has been the use of forced circulation coupled with dropwise condensation of the water vapor. Encouraging results have been reported.

The Heinz Engineering Co. has attacked the problem of finding the proper balance of design factors so that particular vapor compression distillation systems can be arranged to operate at maximum economy. The work includes development of design and cost data on vapor compression distillation plants with compressors driven by steam turbines exhausting into the vapor compression cycle.

Dr. W. L. Badger of Ann Arbor, Mich., is investigating the use of vapor compression distillation in combination with multiple-effect evaporation. Preliminary estimates by the contractor indicate that by this method large-scale demineralization costs can be reduced appreciably below present-day costs by conventional means using either process separately.

Electric membrane processes

At the time the program began, work had already been underway first in Europe and later in the United States on methods of using synthetic resin membranes with electric current to purify industrial fluids, such as sugar solutions. Later, this process was investigated in Holland and England for desalting water, and in 1950 two American groups began limited research work on membrane processes for this purpose.

Some members of this committee will recall that reports concerning the economies of one such membrane process appeared in the press shortly before this program was authorized. As a result of laboratory tests on the small 1952 unit which had been developed previously by Ionics, Inc., the cost of desalting a certain slightly brackish South Dakota water for irrigation uses was estimated to be about $16 an acre-foot.

After the program was started, the equipment was improved and enlarged, and a subsequent contract for laboratory testing a larger unit resulted in a much lower cost for purifying the same South Dakota water—about $4 an acre-foot. Under that same contract more saline water from Arizona was tested on the improved equipment. This water was about four times as saline as the South Dakota water. Based on the tests it was estimated that the cost of purifying that water would be about $20 an acre-foot.

These promising results obtained in the laboratory on brackish waters warranted the field testing of this one firm's equipment. This is being done under contract in Arizona and South Dakota. Overall costs of producing water are progressively

being reduced. However, much improvement of membranes and cell design is necessary. Because of the complexity of membrane research, and the limited number of scientists actually experienced in this field either in this country or abroad, it would be almost impossible to have too much work going on in this field. Research on membranes is being carried on at Brooklyn Polytechnic Institute under the program, and independently by Rohm & Haas Co., of Philadelphia, Permutit Co. of New York, and Gulf Research & Development. Those firms, especially the first, have been very generous in sharing information on their work with the program.

Solar distillation

The role which power or energy plays in the entire conversion situation is of extreme importance. The minimum thermodynamic energy requirement for the separation of fresh water from sea water is 2.8 kilowatt-hours per 1,000 gallons regardless of the method used. This is the minimum energy required for an ideal process, with no losses or inefficiencies of any kind. Every real process will require more than the minimum figure and it appears that about four times this thermodynamic minimum is the best that one could hope to attain. Thus the cost of energy alone will be not less than about 12 cents a thousand gallons ($40 an acre-foot), at 1 cent power or $20 an acre-foot, using power at 5 mills. Investment and operation cost will probably at least equal the energy cost.

In addition to this power cost itself, any large conversion plant would require a very sizable block of commercial power which simply may not be available. At the rate just mentioned a plant to demineralize 1 million acre-feet of sea water a year would require a generating plant of 500,000 kilowatts installed capacity. Because of this need for energy it becomes important that nonconventional low-cost energy such as solar energy, windpower, geothermal energy, etc., be explored vigorously and exhaustively in connection with process development and use.

The use of solar energy to extract fresh water from sea water is also attractive from the viewpoint of national conservation of fuels. To become more attractive economically, lower-cost equipment of greater efficiency is needed. Research is being carried out in an effort to discover ways and means of bringing about those improvements. Such research includes, basic designs by Dr. Maria Telkes of New York University and Dr. G. O. G. Löf, Denver, Colo, use of plastics to reduce costs by Bjorksten Laboratories of Madison, Wis., and a number of small-scale experiments by the University of California.

Critical pressure devices

Separation of fresh water from sea water at pressures of 4,000 to 5,000 pounds per square inch pressures at temperatures in a 700 to 800° Fahrenheit range appears attractive energywise in a large scale. This principle of separating salt water was suggested earlier by the Swedish inventor Baltzar von Platen who also is given credit for having invented the Electrolux refrigerator. Von Platen and his associates stopped work because of problems now believed to be solvable namely corrosion and scale formations. Research is underway at Nuclear Development Associates, White Plains, N. Y., to determine the technical feasibility of the method. Two of the problems to be solved are those of corrosion and scale formations at these high temperatures and pressures.

Osmotic processes

A different way to use membranes to desalt water is by use of hydraulic pressure. Although theoretically possible, it was not until research workers at the University of Florida, under a program contract, discovered the right type of membranes that technical feasibility could be demonstrated. The work, so far, has been on a very small scale, in the laboratory and much remains to be done to develop a practical process. However, the results so far are encouraging.

Another approach to use of these principles is being investigated at the University of California at Los Angeles.

Still another method in this field which may prove to be very important is that proposed by Dr. Murphy, State University of New York. He is developing an osmotically power permselective membrane device using the energy of the sun instead of electrical energy.

Solvent extraction

There are possibilities for using solvents to take fresh water out of salt solution and leave the salt in the brine. Exploratory research at the Texas A. and M. Research Foundation has shown that solvents of that type do exist and that their properties make possible a technically feasible process for obtaining desalted water.

Additional research is being planned to determine whether economic feasibility appears possible.

Separation by freezing

Ice frozen from saline water contains much less salt than the original water. Although basically promising an economical method of separation by freezing has never been developed, because of numerous practical difficulties. Research at the Applied Science Laboratories, State College, Pa., and at the University of Washington at Seattle is now being carried out under the program in an effort to overcome these difficulties.

III. NEED FOR EXTENSION AT THIS TIME

The question may reasonably arise now as to whether an extension of the authorization period is desirable at this time, rather than at the close of the present 5-year period. One answer is this:

Under the provisions of the present act, all of the actual research under the contracts, all reports thereon, and all correlation and coordination of data must be completed by July 15, 1957.

Most research and development contracts are for a period of about a year. Thus it would be necessary to terminate most contracting by about December 1955, 9 months hence, to permit completion of the work under the contract by December 1956, and final reporting of the results and conclusions of the program 6 months later. Thus scarcely any of the appropriations for fiscal year 1957 could be utilized for contract research just at the time when the need for advanced research and development of promising processes is expected to be felt most. Moreover, research of this type is perforce, long range in character. Unless assurance can be given to the private firms and research organizations and particularly to individual private scientists whose ideas are needed that promising studies will be carried to completion, we anticipate difficulty in securing interest of scientists, and in achieving worthwhile results even in fiscal years 1956 and 1957.

Interruption or abandonment of the program after fiscal year 1957 would dissipate a large part of the valuable results already achieved or anticipated, with a consequent loss to the Government.

Furthermore, after two and a half years of work, it is now possible to foresee with greater assurance the chances of success of the entire program.

IV. NEED FOR SOME RESEARCH BY EXISTING GOVERNMENT LABORATORIES

The provision in the proposed amendment to permit an expenditure up to $500,000 for research to be conducted in existing Government laboratories would prove advantageous in a number of ways. Several individual private scientists in private life have had ideas on processes worthy of at least exploratory research effort. However, they do not have laboratory facilities available. Some would be agreeable to having the research carried out at a Government laboratory, but in the absence of specific authority that has not been done. Thus the research has not been carried out. Then there is the situation where Government scientists themselves may have worthwhile research to propose, which they and their laboratory would be best qualified to perform. Another area in which operations in a Government laboratory are valuable is in making unbiased comparisons of processes and in confirmation of research results. In some cases, Federal scientific organizations offer the only satisfactory personnel and facilities to conduct certain investigations.

V. NEED FOR INCREASED AMOUNT OF AUTHORITY AND THE 25 PERCENT ADMINISTRATIVE EXPENSES

As provided in the proposed amendment additional funds would be necessary to carry forward the development of processes. It is usually necessary and desirable that the initial research on development of a process be conducted on a relatively small-scale laboratory basis. For such research only nominal expenditures have been required. Although much of this exploratory research needs to be continued, it was not considered to be the purpose of the program to limit the activities to basic, exploratory, or laboratory research. To accomplish the purposes of the act in developing processes on a scale sufficient to determine the feasibility of the development on a large-scale basis, pilot plants or field tests become necessary as individual processes which show sufficient promise are developed in the laboratory. Such tests are essential in order to obtain reliable

cost estimates and information on the durability of the unit and critical parts, down time, production capacity, power requirements, etc. Developmental work, including field tests of this type, is much more costly than laboratory investigations. However, nearly all such work is handled on a cost-plus-fixed-fee basis. Therefore, if it is adequately inspected and audited no unnecessary expenses are involved. I cannot emphasize too strongly the need for adequate inspection by qualified Government scientists, of all Government contract research work.

The proposed authorization for appropriation of a total of $1,500,000 for departmental expenses is only a small increase on a per year basis of the amount authorized under the present act. From this fund would come not only departmental expenses for the 1953 to 1963 period, but also for the additional 2-year period for completion of research prospects and for the final 1-year period for correlating, coordinating and rounding out the results. It is expected that the small increase rate (from $100,000 a year to approximately $115,000) will cover the increased activity and the resultant increase in coordination and in supervision functions. Particularly as each process reaches the larger field testing stage is constant inspection needed. It has already been clearly shown in the one field test underway that personnel of high caliber, capable of discerning successes, failures and pitfalls and able to recommend changes in direction, must be on hand in addition to the skilled personnel of the contractor.

GENERAL

Every effort is being made to encourage private development of processes and as a result a few industrial firms have undertaken independent research in this field during the past year, and wholehearted cooperation has been received from several organizations now engaged in these activities. It is entirely possible also that some industrial firms may be working on processes without advising the Department of their activities.

In addition the work is being coordinated with that abroad, as it is believed to be essential that every scientific improvement or facility to solve this pressing national problem, be brought to bear, wherever such assistance may be. Program scientists and consultants are obtaining technical assistance from abroad both by correspondence and by personal visits. The latter have proven to be extremely productive. It is planned to continue such exchange of technical assistance and cooperation wherever it is clearly of advantage to the United States program to do so.

Senator ANDERSON. Dean Sherwood.

STATEMENT OF DR. THOMAS K. SHERWOOD, FORMERLY DEAN OF ENGINEERING, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dean SHERWOOD. Thank you, Mr. Chairman. Would it be appropriate if I reviewed the program, and then attempt to answer any questions the committee might have?

Senator ANDERSON. Yes.

Dean SHERWOOD. I testified before the Joint Committee prior to the enactment of the legislation in 1951, at which time my testimony was mostly to do with two aspects of the problem. The first was a review of my study of the cost picture of existing processes, at that time, processes which I believe to be workable and in fact known processes, processes for which the cost data were available, and for which the cost data were quite reliable as engineering cost dataing. These costs at that time were essentially prohibitive from the point of view of the water needs of most communities and certainly for irrigation purposes. In fact, the best I could see at the time suggested a water cost of the order of magnitude of $500 an acre-foot, which is the figure that Mr. Jenkins referred to as about the range of costs by existing processes at the time the legislation was first discussed.

My calculations of costs at that time were based on studies of such processes as ordinary multiple effect evaporation, of the vapor compression distillation operation as developed for the armed services during the war, and of a combination process involving both kinds of equipment.

As I say, the cost in relation to costs which even fairly desperate communities might develop, were not reasonable.

The other aspect of my testimony at that time related to the very large number of ideas which had been mentioned, which had been looked at briefly, which scientists and others had suggested from time to time, and on which there was not adequate information to estimate what the possibilities might be. It seemed to me very clear that among these there might be something well worth developing, and well worth promoting and that what was needed was what we called seed research, the kind of nurture of a nebulous idea that gets it to a point where somebody gets excited about it.

This is the hardest kind of research money to get. If you have some idea with numbers that look promising, you can get some people to spend money for it, but at the stage where it is just an idea, it is hard to get support. But there seemed to be a large number of possibilities among such things as those which have been mentioned by Mr. Jenkins, such as this osmotic membrane idea, and so on.

Accordingly, at that time I argued along two lines. First, that the large expenditure for a so-called demonstration plant to produce water by a known process at a high cost would not be a good idea in that relatively little would be learned by demonstrating what you already knew. At the same time I argued that what was really needed was the nurturing of these nebulous ideas. The bottleneck was not money but ideas. A number of others agreed with this position. In fact, the bill as passed took the form in line with those arguments.

Since 1951 I have been in contact with the program and have been informed about its progress. In fact, I have reviewed some of the proposals as submitted to me by Mr. Jenkins. I think I know the general way in which it has worked.

In the first place, I would offer my opinion that it has been exceptionally well run. It has been efficiently well run, and followed the lines of operation which I think make very good sense, indeed. This original brochure which Mr. Jenkins and his office produced, listing all the conveivable ways that one might think about if one went about to invent a process, was a really excellent document, and a very fine idea, because it did exactly what it was intended to do—it got a lot of people excited about the problem and thinking about ways they could do better and produce a number of ideas. This showed excellent judgment to get this document out at the beginning. That was an efficient thing to do when you are after ideas.

I think the program and the selection of projects has shown a good balance between the relatively routine improvement of known methods and known devices, and the long shots which one might say were almost fantastic, but still in this kind of thing should not be overlooked. I think to go all in one direction or all in the other would have been a mistake. I think the facilities permitted looking at both kinds.

It seems to me that the program has had adequate advice from, one might say, reputable scientists. I think the people engaged in

the contracts among the advisers and among the consultants are people who command the respect of the engineers and scientists of the country. I think the program, therefore, briefly, works as intended. It brings out ideas, and I think myself that this is basically the function of the program, and would be my interpretation of the purpose of the original bill.

I believe that the 5-year period is too short to collect and pursue these ideas because they don't just come along for the asking and one leads to another. So I would think that it is entirely reasonable and proper that the time period be extended, with at least the support that it has had on an annual basis.

I think in the next 3 or 4 years it will be desirable to build 2 or 3 pilot plants, and these will be more expensive than some of the operations of the program to date. So the funds will be a little tighter than they have been if these pilot plants are built.

I might distinguish between a pilot plant and a demonstration plant. My definition of the words would be that a demonstration plant is a plant essentially constructed to make fresh water by a process that is known and in which one has confidence. A pilot plant is a plant of a somewhat smaller size ordinarily built to work out some of the problems and esssentially not to make fresh water, if you please, of a type which cannot be worked out in a laboratory, and there are a number of these.

For example, one of the possible troubles with this membrane process is very tiny particles of colloidal impurities may ruin the membranes, and the only way to find out that is to operate one of these devices over a long period of months with the water in which you are interested.

Consequently, a pilot plant such as the one in existence now operating on the brackish water in the West is very definitely in order. The corrosion and scaling problems, using sea water, in connection with either this critical pressure device or in connection with the vapor compression evaporators, are problems which would be essentially impossible to get data on which one might get data in the laboratory, and have very much confidence in the ability to predict the operation of a demonstration or commercial plant over a period of years. So a pilot plant again may be in order in this connection.

These pilot plants are certainly more expensive than the kind of operation or kind of research which the chairman mentioned as going on in Florida on ultrasonics where the money simply goes to determine if an effect exists. If the effect exists, which the man is looking for, then it is worth pursuing. That is a relatively inexpensive type of study. It is not much more expensive than Dr. Fleming's discovery of penicillin, when it flew into the window. But the subsequent idea from there to the large-scale distribution of penicillin costs hundreds of millions of dollars, and the development of this idea may, too. But the first step is to determine the effect and locate the antibiotic.

Just in passing, a word about this item in the new bill on the use of Government laboratories and people. I would say only that in the situation where ideas are the bottleneck, it would seem to me ridiculous to rule out of consideration any area from which one might get a usable idea. It just makes good sense to accept the fact that these people, as well as people in Europe, might have some ideas that we would like to pursue and very likely have them pursue them in their own laboratories at the outset.

Finally, just a word about my conclusions about the present state. I think that the promising processes at the moment are the ionic membrane process, the vapor compression development of Dr. Hickman, a combination of vapor compression and multiple effect system, which is the subject of a recent study by Dr. Badger of Ann Arbor, no connection with Badger Manufacturing Co., and finally this critical pressure device.

I think these indicate that water might be made even today for about half the cost that I thought would be possible a year ago. I think the costs are somewhat higher than the cost figures that are seen in the newspapers from time to time about making fresh water from the sea, but I think very real progress has been made, and in round numbers I would say that the cost has been halved by workable processes which one might go ahead and make today.

Senator ANDERSON. Has there been any thought given as far as you know with the possibility of tying in the new reactor programs with the experimental programs along that line? We are dealing with high pressures in all sorts of experiments of that nature. Here you come along with these boiling water types of reactors and so forth.

Dean SHERWOOD. The same kind of technical information is useful in both areas. There is, of course, in this scientific fraternity an unusually good communication system whereby scientific facts get around very rapidly. I would say in connection with atomic energy only this: Just in the same way that atomic power may become interesting and economic in competition with steam power, even perhaps more probably is that low-grade energy in the form of heat might compete with fuels and therefore it would seem that the possibility of using heat energy from reactors in these fresh-water devices such as the multiple-effect evaporators is perhaps even better than the possibility of making competitive power from reactors.

Senator ANDERSON. That is exactly what I was wondering about. I think there might be something there. We are talking all the time about how nice it would be in some of these types of reactors if we did not have to take the heat and transform it into steam, and take the steam and transform it back into energy, and so forth, we would be able to do a lot of things. If that were true, you might possibly find some way of locating a reactor where sea water was a circulating element in it, and come out with some surprising results.

Dean SHERWOOD. Mr. Chairman, I am not well informed on the subject of reactors, but it is my understanding that the cost of producing low-temperature heat by a reactor would be very much less than that of producing the higher temperature heat that it is necessary to make power. I think, for example, the Brookhaven reactor has a very substantial amount of low-temperature heat going up the stack which at one time they considered recovering by the use of a waste-heat boiler. That is the kind of low-temperature energy which would be useful for making fresh water from the sea, but which would not be useful for making power. So there is, I think, a slight edge in the use of atomic energy for this kind of a purpose over atomic energy for power in competition with steam power and heat from fuels.

Senator ANDERSON. Does that conclude your statement?

Dean SHERWOOD. Yes, sir. I would be glad to attempt to answer any questions along the lines of your interest.

Senator ANDERSON. Mr. Appelbaum.

STATEMENT OF JOSEPH APPELBAUM, VICE PRESIDENT, OIL, CHEMICAL, AND ATOMIC WORKERS INTERNATIONAL UNION, CIO

Mr. APPELBAUM. Mr. Chairman, my name is Joseph Appelbaum. I am vice president of the Oil, Chemical, and Atomic Workers International Union, CIO, with headquarters located in Denver, Colo. I am testifying here in behalf of the National CIO in support of the extension of the Government's saline water program. Until recently and prior to the merger of the Oil Workers International Union, and the United Gas, Coke, and Chemical Workers Union, I was western regional director of the United Gas, Coke, and Chemical Woskers Union. In that capacity I appeared before the House Committee on Agriculture in Whittier, Calif., on November 12, 1953, in support of the further extension of the Government's saline water program. At that time, I said, and I quote:

> CIO today is happy to pay tribute to the great foresight of those legislators of the West who realize the great social and economic potential that lies in the sea at a time when no one else but a handful of scientists share their vision.

Since that time we in CIO have been impressed with the developments which have occurred in this field. We know that there has been proven a practicality to this program which now justifies the most optimistic hopes of our earlier testimony. We know that an application of vigor and intelligence can bring an early solution to many of our most pressing water-shortage problems.

Yet we stand here today in a period when the pressure of water shortage is increasingly a critical problem throughout the United States. In the past there have been occasions when it was safe to say that the water-shortage problem was primarily the problem of the West. With the passage of time, the growth of population, the increasing need for water in industry, agriculture, and for the domestic use, it is now clear that water shortage is a national problem.

Therefore, gentlemen, it seems to me that the efforts of the past in solving this problem must be reexamined in the light of the new pressures, and steps must be taken to apply knowledge and technology which have been developed in this field in a more vigorous way looking toward the solution of this most pressing problem.

In the past week we have found general acceptance to a solution of one of the Nation's most pressing problems. The Salk vaccine may well end the fear of the dreaded disease "polio." Given adequate funds and the application of trained technicians we can solve some of our most serious problems. And no problem today is more serious than the growing shortage of water. Last week as I moved from St. Louis, my former home, to Denver, Colo., I experienced the effect of the snowstorm in eastern Colorado. This is one of the areas which has a critical water shortage. This storm, which delayed my trip, was greeted with jubilation in the eastern Colorado area. The more snow that fell the more water that would sink into the ground, the less the area would be affected by the scourge of the dust blow which is affecting this whole area. It is now taken for granted in the West that in the year 1955 this country will see the biggest duststorm in the creation of a new dust bowl with all its devastating effects covering 25 million acres.

Mr. Chairman, I propose that we immediately expand the Government's saline water program if for no other reason than to seek to end this menacing dust-bowl condition, and that we provide the program with funds equal to $1 an acre of the area affected, and that we call upon the scientists and the technicians and the irrigation experts to figure out ways and means to bring an end to this condition brought about in such large part by the shortage of water.

Mr. Chairman, I said earlier we have been encouraged by the progress of this program. That is to say, we have been encouraged by the few experiments which prove that the program has developed a potential technology and an economic range of operation which can release the giant source of the ocean to meet the water needs of almost any area in the world.

The development of a power source known as the package reactor in the field of atomic energy means that we can now provide the technology of the saline-water program to the most critical areas throughout the United States and the whole world and use our developments in this field to meet the most pressing needs of the underdeveloped countries of the world in their economic developments.

Mr. Chairman, the CIO believes that this program should be given a priority equal to that of our most pressing military development programs so that we can show the world that we are prepared to effectively aid them in raising their standard of living.

Recently the secretary of our national committee on resources development drafted a memorandum on The Application of Atomic Power to the Demineralization of Sea Water for Irrigation or Domestic Use. Mr. Chairman, without reading this memorandum, I would like to place it in the record at this point.

Senator ANDERSON. That may be done.

(The memorandum referred to follows:)

MEMORANDUM RE THE APPLICATION OF ATOMIC POWER TO THE DEMINERALIZATION OF SEA WATER FOR IRRIGATION OR DOMESTIC USE

From: Leo Goodman, secretary, CIO national committee on atomic energy, power, and resources development.
Date: March 15, 1955.

There has been since 1952, an appropriation of $400,000 a year for the saline-water conversion program by the Congress to the Department of the Interior. The goal set for this program has been the reduction of acre-foot of potable water at a cost of approximately $125. This is based on a survey of the cost of water to 400 American cities.

For irrigation purposes the objective has been production in cost to $40 per acre-foot.

Substantial success has been achieved through the use of an ion transfer membrane demineralizer. This has been tested for both brackish water and sea water. Brackish water in South Dakota has been demineralized at an estimated cost of $4 per acre-foot predicated upon an estimated conversion plant installation cost of $1,700,000, and salt content of 855 parts per million.

In Arizona where the water contains 4,635 parts per million salt, the estimate is that brackish water can be made potable with a $10 million investment and a cost of $20 per acre-foot.

In Texas estimates run to $40 per acre-foot in a $20 million plant based on salt content of 10,000 parts per million. This process uses the property of certain plastic membranes to pass only electrically positive particles (cations) and other membranes to pass only electrically negative particles (anions). When salts are dissolved in water they break up into equal quantities of cations and anions which move in opposite directions in an electrical field. The power requirements to reduce salinity to approximately 350 parts per million were experimentally determined. The energy demand per gallon treated in a given sized unit was

shown to be inversely proportionate to the production rate; that is the higher the production rate the lower the energy consumption per gallon. In producing a water product with 350 parts per million salt content to produce 10 acre-feet per hour, that is salt content of 350 parts per million from sea water which contains approximately 35,000 parts per million is shown in the following table:

Membrane area [1]	1	Sea water [2]	1,600
Do	3.3	Do	480
Do	10	Do	160

[1] In million square feet.
[2] Kilowatt-hours per thousand gallons.

For each of the types mentioned above of the total cost per acre-foot the power cost was:

Type	Total cost	Direct power cost
South Dakota	$4.08	$2.56
Arizona	19.53	10.34
Texas	40.07	22.60

The above estimates are based on the assumption of 0.3 cent per kilowatt-hour.

Using the above estimates the Bureau of Reclamation has concluded that portions of the southern California and Texas coastal regions where water requirements exceed present local supplies, and those which can be developed, it is physically possible to meet all the future water requirements of those areas with converted sea water. (Saline Water Conversion Program, Research and Development Report No. 3, entitled "Potential Use of Converted Sea Water for Irrigation in Parts of California and Texas," p. 2.)

The fundamental problem, therefore, is the lack of power in areas which need this program the most. Southern California and Texas do not have available the large blocks of surplus power which would be needed to make such a program feasible at this time.

It is proposed, therefore, that the Atomic Energy Commission build some of its experimental atomic power reactors in these areas of sufficient size to supply the power necessary for further development of the saline-water program.

Mr. APPELBAUM. It shows, Mr. Chairman, that the direct power costs of the electrodialysis method of demineralization of brackish or sea water constitutes more than 50 percent of the total costs. But it also shows the direct advantage which is gained from increasing the size of units involved. One million square feet of membrane area requires 1,600 kilowatt-hours per thousand gallons. Ten million square feet of membrane area reduces the power requirement to only 160 kilowatt-hours per thousand gallons. It is clear, therefore, that this program needs some immediate large-scale experimentation. It is likewise clear that we will never get the "bugs" out of the technology of this development until we try it in many places and on an increasing larger and larger scale. Our technicians and members of my own union have called our attention to the many places where this program can be immediately put to test. In some of the very area affected by the dust bowl there are oil wells producing quantities of salt water which could be demineralized and used as potable water. The Department of the Interior's Third Annual Report on Saline Water Conversion says:

The work accomplished so far indicates that attainment of the first goal of winning fresh water from sea water at a price which municipal users and some industries might pay, and the conversion of brackish water to irrigation uses, seems to be in sight although much work will be necessary before either can be brought to realization.

Mr. Chairman and members of the committee, while I endorse the intention of S. 516, I recommend on page 2, line 5, the phrase "$6 million in all" be stricken and in place thereof the committee substitute the phrase "$25 million a year," and in line 17, page 2, the figure "$500,000" be stricken and in place thereof "$5 million."

Mr. Chairman, I am sure you are more acquainted with that as an individual than I on the question of the water shortage as such, as indicated in the prepared statement, no longer affects one particular area. It affects our whole Nation. Many people are involved. The way my organization looks at it, and the way I look at it personally, the water itself is life. I think as a representative of my union and as a family man, and as a citizen of this country, that we have got to put everything we can behind the exploitation of this program to see that the water is made available for our people.

The indications have been that there have been some practical developments in it, and our contention is that this program should be enlarged, and we should enter into the field in a practical way, and through that obtain more experience on a larger scale.

Senator ANDERSON. I appreciate that statement. I assure you I had no idea what you were going to testify to when you came in here. My earlier questions about the size of this money, and my question a moment ago about taking a reactor type that depends upon various types of pressures and see if it could not be located nearer sea water, and perhaps learn something about the demineralization of sea water at the same time has been echoed in your statement. I appreciate very much your confirmation of what had been suggested to me by the things we have been going through in the atomic-energy program.

We had a hearing yesterday afternoon on military application of the atom. It is being repeated again tomorrow. We have a hearing every 2 or 3 days for the next several weeks on that. The military application of the atom is important. But I sometimes feel that the people over in the conference that is going on now in the Far East would be somewhat interested in what we are planning to do in peace, and what contribution we can make to their ultimate welfare. We can make it by programs of this nature and make it very rapidly.

I am happy your organization has made that position.

Mr. APPELBAUM. May I make one more statement without belaboring the time of the committee. I would like to say one other thing, Mr. Chairman. It is not a question of can we afford it. It is a question of can we afford not to do it. In my way of thinking, water is just as important as any other peaceful material, as far as defense is concerned. As aptly as you have put it, I think we have to show the free world what our intentions are. When we acquire the know-how through the application of this particular program in a large expanded way, I think it is our duty as people under God to show these people in the other parts of the free world what we learned and show them how to work it and supply them with the necessary water.

Senator ANDERSON. I am very happy about your testimony. As I have said, I have been greatly disturbed over the water situation, and the possibility that we could have some way of making a contribution to that problem here and elsewhere. I know how much money we plan to spend for defense. I do not regret any of it. But a very tiny fraction of 1 percent of it spent on the development of this type of program might make possible the protection of some of

the billions we are pouring into defense at the present time. I am thinking particularly of the fact that we are in this controversy steadily with California over water, which the development of a program to its final conclusion would completely eliminate. There would be no reason why Los Angeles would want to take its water out of the California River if it could get its water out of the ocean at an equivalent price, and it might be possible for it to do so. If that happens, then you free immediately a lot of water for areas that are being questioned now. I am thinking of a bill that is going to come to the floor shortly, the Arkansas-Fryingpan project, which deals with the diversion of water from the upper Colorado area. California very properly, I guess, asks what is that going to do to the character of the water we are going to get that is left in the stream. Will it carry a larger proportion of solids and therefore not be usable by us. We want to know. We are worried about it. At the same time, Colorado Springs there with a new Air Academy, and with a great many mineral operations getting ready to start, and in need for a great deal of water, that water can be supplied very quickly by the Arkansas-Fryingpan project.

I cannot help but think of my own State where we have in a very narrow stretch of country the Los Alamos Laboratory, which has had a great deal to do with weapon design for our modern arsenals, and the Sandia base which has had a great deal to do with the manufacturing techniques of our weapons, and the White Sands Proving Grounds, which developed rockets and intercontinental missiles, everyone of the areas short of water, all possible to be served by a transmountain diversion from the upper Colorado River, and the whole project being questioned by California because it represents a diversion of the stream, and I am not questioning that. All that could be eliminated very quickly by the use of water of this character.

Are there other witnesses?

If not, thank you very much. I regret that additional members of the committee were not here for this discussion. I do want to say that former Secretary of the Interior Oscar Chapman was trying to be here. He found that his doctors want him to keep quiet for a few more days. I do want to recall that he was very much interested in this program. He gave us a great deal of encouragement. He assigned Mr. Lineweaver to the project when he was Secretary, and required him to report directly there to the Secretary. I am sorry he was not able to be here.

I think I will include here the article in the New York Times of February 17, 1955, in which David Lilienthal, former head of the AEC, sees an all-out water famine, and calls for an all-out crash program to develop a feasible way to concentrate the removal of minerals from sea water and make it useful for irrigation and industrial needs and human consumption.

(The article referred to follows:)

[From New York Times, February 17, 1955]

LILIENTHAL SEES A WATER FAMINE—AEC EX-HEAD SAYS NATION OVEREMPHASIZES ATOM AS SHORTAGE GROWS

(By Jack R. Ryan, special to the New York Times)

CHICAGO, February 15.—David E. Lillienthal said today the Nation was overemphasizing the atoms-for-peace program in the face of a much more urgent problem—a growing water shortage.

"However important the multi-billion-dollar search for economical electricity from atomic fission may be, it does not compare with the need for action on our threatened water supply crisis," he declared.

He called for an "all-out crash program" to develop a feasible way to concentrate and remove minerals from sea water and make it useful for irrigation, industrial needs, and human consumption.

Mr. Lillienthal was a principal speaker at the annual meeting of the American Institute of Mining, Metallurgical and Petroleum Engineers at the Conrad Hilton Hotel.

He was Chairman of the Tennessee Valley Authority from 1941 to 1946 and Chairman of the Atomic Energy Commission from 1946 to 1950. He now is Chairman of the executive committee of the Minerals and Chemical Corporation of America.

CITES POPULATION GROWTH

He said a successful sea-water process might be achieved with only a fraction of the cost in dollars and technical talent being spent on the nuclear-power-generating program. He said it would help meet one of the gravest problems a rising population and industrialization presents."

"Most authorities feel it will be 20 years before the atom can compete economically with other fuels for generating power," he continued. "By that time we expect to have 60 million more people in this country—but we can't stockpile water and there's no present indication we'll have any increased water supply then.

"It has been said that the expensive stress on atomic electrical power is justified by the cold war. Well, the cold war has covered more than one boondoggle.

"And what would be a greater cold-war weapon in arid, overpopulated India, for example—more electricity or a great increase in water for farming? Or in the arid countries of the Middle East? In many parts of the world, water is the very condition of life, and the lack of water spells hunger, discontent, and warfare."

Mr. Lillienthal also urged the "stockpiling of new technical knowledge and new processes" for making use of domestic lower grade industrial minerals. In this way, he said, the United States could rely on its own minerals or substitute materials in times of trouble.

NOTES MINERAL IMPORTS

"We are importing minerals at a great rate, and this should be encouraged" he said. "But we should not be blind to the real possibility that even though there will be no shooting war—as I happen to believe—we may find our imported sources of mineral supply constantly interfered with, uncertain and costly."

Another speaker today was Capt. Howard T. Orville, United States Navy, retired, weather consultant to the Bendix Aviation Corp. and chairman of the National Advisory Committee on Weather Control. This committee was appointed late in 1953 by President Eisenhower to evaluate public and private experiments in weather control.

"Today we may be facing one of the greatest droughts in history," Captain Orville said. "New reports of drought conditions are received daily from all over the Nation. Denver has banned city sprinkling even in winter; Baltimore has just experienced the second driest year in 50 years.

Drought conditions are currently reported in 944 counties in 18 States extending from Texas northward to Wyoming and from Georgia and Virginia westward to Nevada."

He said cloud-seeding operations to increase rainfall or snowfall had been or were now in progress in almost every State of the union "although the beneficial results are still questioned by many." Commercial "rainmaking" has stabilized into an estimated $1 million-a-year business.

The engineers' 5-day meeting will conclude tomorrow.

The CHAIRMAN. We have a statement from Hon. James Roosevelt, Member of the House of Representatives from California, which will be included in the record.

STATEMENT OF HON. JAMES ROOSEVELT, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. ROOSEVELT. Mr. Chairman and members of the committee, I am delighted at being able to express myself on a subject—water—that has been of paramount importance to the West from the time the first pioneer forged his dusty way across the country, and one that is becoming of increasing importance in the East as well. As you know, gentlemen, I have also had some experience of that area.

I speak as one who has an intense interest in the prosperity of our entire country, one whose faith in its continued growth and prosperity has often been expressed. I am not one of those who believe, like Malthus, in occasional hardship and distress, or even war, for the purpose of reducing the population to a point where it can live, no, exist, on depleted or wasted natural resources. We had one experience with that philosophy a while back, now showing up in the smaller numbers of our population between 15 and 25, one which will reverberate in future generations in the smaller number of children born to that smaller age group. This philosophy, which the Democrats sought to overturn by measures designed to increase the prosperity of the country, has now been revived by those who would waste our resources, who, when they do grudgingly take steps that would better utilize them, make sure that they are too little—I sincerely hope they are not too late.

I say this because the same measures which would benefit our own country, the same knowledge gained in this saline water conversion program would, without significant extra expense, go a long way to raising the standard of living throughout the world.

By making North Africa, at the time of Carthage one of the most fertile areas in the world, bloom again, as once it did, by making other desert areas flourish, we can bring food to starving millions and uproot the major economic unrest that led to communism. When we can do this through the knowledge gained from our own program, without extra expense beyond what a realistic program for our own needs would be, I am all for it.

Let's look at it this way. Even if we had no economic need for the program in our own country—and the dust-bowl areas, harbingers of future Saharas, cry out that we do—it would be invaluable in an attempt to bring a permanent peace to the world.

Like David E. Lilienthal—you gentlemen may remember that he administered both the atomic-energy program and a major water-development project—I also call for an "all-out crash program" to develop a feasible way to concentrate and remove minerals from sea water and brackish water to make it useful for irrigation, industrial needs, and human consumption. At this point I should like to introduce into the record his statement.

Placing the importance of this program, now represented by a trifling appropriation of $400,000 a year for a limited time, over that of producing electricity from atomic energy, he asked:

* * * What would be a greater cold-war weapon in arid, overpopulated India, for example, more electricity or a great increase in water for farming? Or in the arid countries of the Middle East? In many parts of the world, water is the very condition of life, and the lack of water spells hunger, discontent, and warfare.

And then let's look at our own country. Westward expansion, new frontiers, more agricultural land, have made possible our present standard of living. But the coast was reached many years ago, and readily feasible plans of irrigating more land through conventional methods are dwindling. It has been estimated that if every drop of water in our western rivers were utilized for irrigation, not more than one-fifth of the potentially arable land would be reached. Even the eastern parts of the United States long thought of as an area of water surpluses, is feeling the pinch. Cities have had to ration the use of water. Good industrial sites have had to be turned down because of an insufficiency of water of suitable quality. Increasing stream pollution has made the task of supplying not only potable water, but industrial water as well, an increasing problem. Look, too, at the havoc wrought in eastern farm crops when the rains fail. That's our problem now—what will it be in 20 years? As Mr. Lilienthal said in his February 15 speech:

> By that time we expect to have 60 million more people in this country, but we can't stockpile water and there's no present indication we'll have any increased water supply then.

We have the solution in our hands today, a way to make the deserts of my State bear as fruitfully as the irrigated lands of the Imperial Valley—a desert which has become the most productive agricultural area in the world—a way to make the quarrels between States over water, one of the major interstate irritants and sources of litigation for many years, as trivial as the quarrels of children over the rills left by the morning rain.

Let's take the saline water conversion program, which has shown such promise in its first hesitant steps, supported by a trivial annual appropriation, and make it stride like the infant Hercules it is. Let's have no talk, blown up as through a major outlay were involved, merely of a program extended until 1963, with an authorized total appropriation of $6 million.

This proposal to triple the total authorization for the program sounds as though it would permit a vast increase in research. On an annual basis, however, it is an increase of a mere $200,000. That is, it is that large if the Bureau of the Budget, which has not been overly sympathetic, permits it. Surely our country, with its vast resources can afford more than this trifling amount to make available for our farms, our cities, and our industries, the water they so badly need. Is this the crash program which will prevent India's millions from dying of starvation, will relieve population pressures throughout the world, and help defeat communism, through peace, and not through war, while still we can?

We are within reach of that goal. Field tests have been made with one process which bids to reduce the cost of purifying brackish water to a price where it can be used for irrigation and municipal water.

Right now, I venture that it is cheap enough to be used in emergency situations to prevent the total loss of crops. Other processes for making sea water available for potable and industrial uses on a large scale are being tested and improved. I urge that you gentlemen push these developments, and others which may be promising, by authorizing a program large enough to develop the potential in

the program within a short time. Ten million dollars a year would be about right, to my way of thinking.

I would furthermore amend the act of July 3, 1952, to provide for dissemination of the information obtained not only to the people of these United States, but to all countries experiencing water shortage or water salinity problems—which would probably include most nations on this globe.

Further to implement the purpose of this act, which is to benefit the people of these United States, whether the information disseminated be here or abroad, I should make one further amendment in the act. I should provide explicitly, rather than by committee directives to the Department of the Interior, as occurred in the passage of the original act, that inventions made as a result of the research under this program be made available to the people of the United States. Let us not permit the creation of a new monopoly by those who have been paid by the taxpayer to develop an economic method of desalting water thereafter to say, "We will permit only those of you whom we choose to become the beneficiaries of our largesse." In such a program as this, a free nation can again demonstrate its superiority to any system of dictatorship.

The CHAIRMAN. We also have a statement from Hon. Thomas H. Kuchel, United States Senator from California.

STATEMENT BY SENATOR THOMAS H. KUCHEL, UNITED STATES SENATOR FROM CALIFORNIA

Senator KUCHEL. Mr. Chairman, this bill has my wholehearted approval. Its passage is desired by the people of my State, and I believe it is also in the Nation's interest.

The 82d Congress took a farsighted step when it authorized and appropriated for a program of research in the problems of converting saline waters for beneficial use. Many areas of the United States are reaching the end of their fresh-water resources. This can be found in California, but it is also becoming ominously apparent elsewhere, as witness the critical shortage of water in New York a few years ago. In California, the water engineers of the State estimate that underground water tables will be subjected to an overdraft of 5,500,000 acre-feet in 1955. Wells in the coastal counties of my State have been deepened to such an extent that salt-water intrusion has ruined many of them. In order to maintain the life of our cities, our industry, and our agriculture, water is moved for hundreds of miles by canal and ditch, as in the Central Valley project and the Los Angeles aqueduct and other works of the Metropolitan Water District. We have but a few remaining potential projects such as the Trinity River diversion, for which I have legislation pending, and the State's Feather River project. But for a number of years, my State has turned its attention to the possibilities of converting water from the Pacific Ocean into fresh water for our population, our industry, and perhaps even our agriculture.

The California State Division of Water Resources, and the University of California, is engaging in studies of the problem and of the possibilities of salt-water conversion. It was a matter of great encouragement to us when the Federal Government undertook in 1952 to participate in similar activities.

Those activities have had the important result already of narrowing the field of research, and scientists under contract with the Department of the Interior are now able to anticipate reaching firm conclusions within another few years. The Department has advised this committee that unless the authority of the 1952 act is extended, it will have to commence this coming December to bring the program to a conclusion. The research contracts then in force would have to be concluded during calendar year 1956 so that the Department could complete its final report under the 1952 act by July of 1957, its terminal date.

S. 516 will protect the investment the United States has made to date in this vital research work. More than that, it will be an investment in the future of our country. Fresh-water sources are not inexhaustible. They are subject to weather fluctuations. They are under the pressure of rapid population growth and increasing industrialization. In making it possible for saline-water research to continue, the Congress will be taking out an insurance policy, at a small premium against the possibility of widespread economic losses, and even disaster, in the years ahead.

Senator ANDERSON. Thank you all very much.

I have a statement for the record from former Secretary of the Interior Oscar L. Chapman on S. 516.

STATEMENT BY OSCAR L. CHAPMAN, FORMER SECRETARY OF THE INTERIOR DEPARTMENT, ON S. 516

I am pleased indeed to have this opportunity of presenting my views to this committee for which I have a high regard and a sentimental attachment because of my years in the Department of the Interior. I have been privileged to discuss with the members of this committee many subjects of national interest and it is especially meaningful to me that you have invited my comments in connection with S. 516, a bill by Senator Case to amend the act of July 3, 1952, which relates to research in the development and utilization of saline waters.

Some of you may remember that this idea for the development of new water resources through the removal of salt from brackish and saline waters was initiated during my administration as Secretary of the Interior. It was proposed by the Department at that time because of the obvious need for providing additional supplies of water for domestic and related purposes. I am pleased, of course, that this program, now that it is reaching the end of its preliminary stage, is now proposed for extension. However, I am not so happy that the extension does not also include a substantial expansion, in view of the fact that the need for water grows not only as our population grows and not only in one area but all over the country.

Only recently, the Washington papers have carried items, perhaps not drawing much attention, pointing out the fact that across the river in Virginia there is going to be rationing of water during the coming summer. I think most of us will recall that last summer there was a shortage of water in New York and, mind you, there are areas where water is ordinarily plentiful

I think that this program is important, too, because as a nation which frequently points the way, we can, while directly benefiting ourselves, indirectly benefit large areas of the world's surface where populations could develop new production from the earth if nearby saline water could be made available for domestic and related uses.

Since the enactment of this program in 1952, as I think has been pointed out by the Department in its report on the bill, new reservoirs have had to be built; water is being transported over great distances; the water table has been lowered as the result of supplementing the water supply by new wells; the Geological Survey is concerned about the lowering of the water table. It appears to be clear to him who will look that our water resources, those upon which we normally rely, are diminishing or are being contaminated. For the future of the country and of our citizens who, happily for us, are increasing in number daily, we must find new supplies.

I think it is important to note here a point that I have tried to stress on other occasions. Although this, on its face appears to be purely a civilian matter, it is nonetheless closely and intimately entwined with the defense of our country. Water, I need hardly point out, is an imperative ingredient for food and other products and for the maintenance of both our military and civilian population. Water is also, I believe, of growing importance as a cleanser following atomic attack. Thus it would seem to me that we need to devote every engergy to the experimental work now going on and it should be continued and enlarged and enhanced, in order to provide our country at the earliest possible time with a way of producing substantial, additional quantities of necessary water at a cost which will be reasonable.

I think that there has been testimony before, and probably would be again, that private industry is not yet prepared and does not feel justified in undertaking the developmental work of saline water conversion to the extent it should be carried on at present. At a later point it may be that water companies of larger or smaller size, or private, cooperative, or municipal agencies, may wish to enter this necessary field. As of now, however, it is up to the Federal Government to maintain and to accelerate the program now underway.

I think that all who have participated in this program so far are delighted by the fact that substantial progress has been made. However, it is admitted that considerable work remains to be done, even to attain the initial goals which were 38 cents per thousand gallons for municipal water and 12 cents per thousand gallons for irrigation water. Nonetheless, the goal is in sight and, in my judgment, if I may give it to the committee, it is a goal that should be reached as quickly as scientific and technological progress will permit us to reach it.

It is for these reasons that I am rather distressed that the bill now before you, although on its face covers a 10-year period and authorizes an appropriation of $6 million, actually does not do this.

Looked at analytically, the bill before you is a proposal to extend the present act through fiscal year 1963, namely, for another 8 years and the authorization, while it speaks in terms of $6 million, includes approximately $1 million already expended and when the sum allowed for administrative expenditures is deducted from the total, leaves perhaps a little more than $3 million for actual work.

We need pilot plants. We need soon, I would suggest to you, a demonstration plant, something on the order of the one established at Rifle, Colo., for the development of oil from shale, or the one at Louisiana, Mo. (now unhappily closed), to develop oil from coal.

It is my thoughtful judgment that while extending this program at least until 1963, or perhaps through fiscal 1965, the authorization should be increased to $25 million in order that the Department of the Interior can push this program with all the energy, the imagination, and the sincerity which it deserves.

It was this committee which helped initiate the program in the first place. I think it was at that time that I proposed a $25 million program. I renew the suggestion because it seems to me that time has demonstrated that if the program was necessary in 1952, it is even more necessary now. One needs but little vision to see that it will become increasingly important in the years that lie ahead.

Thank you for this opportunity to submit my views on this vital subject.

(Thereupon at 12 o'clock noon, the hearing was concluded.)

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